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MAKING KNIVES & TOOLS

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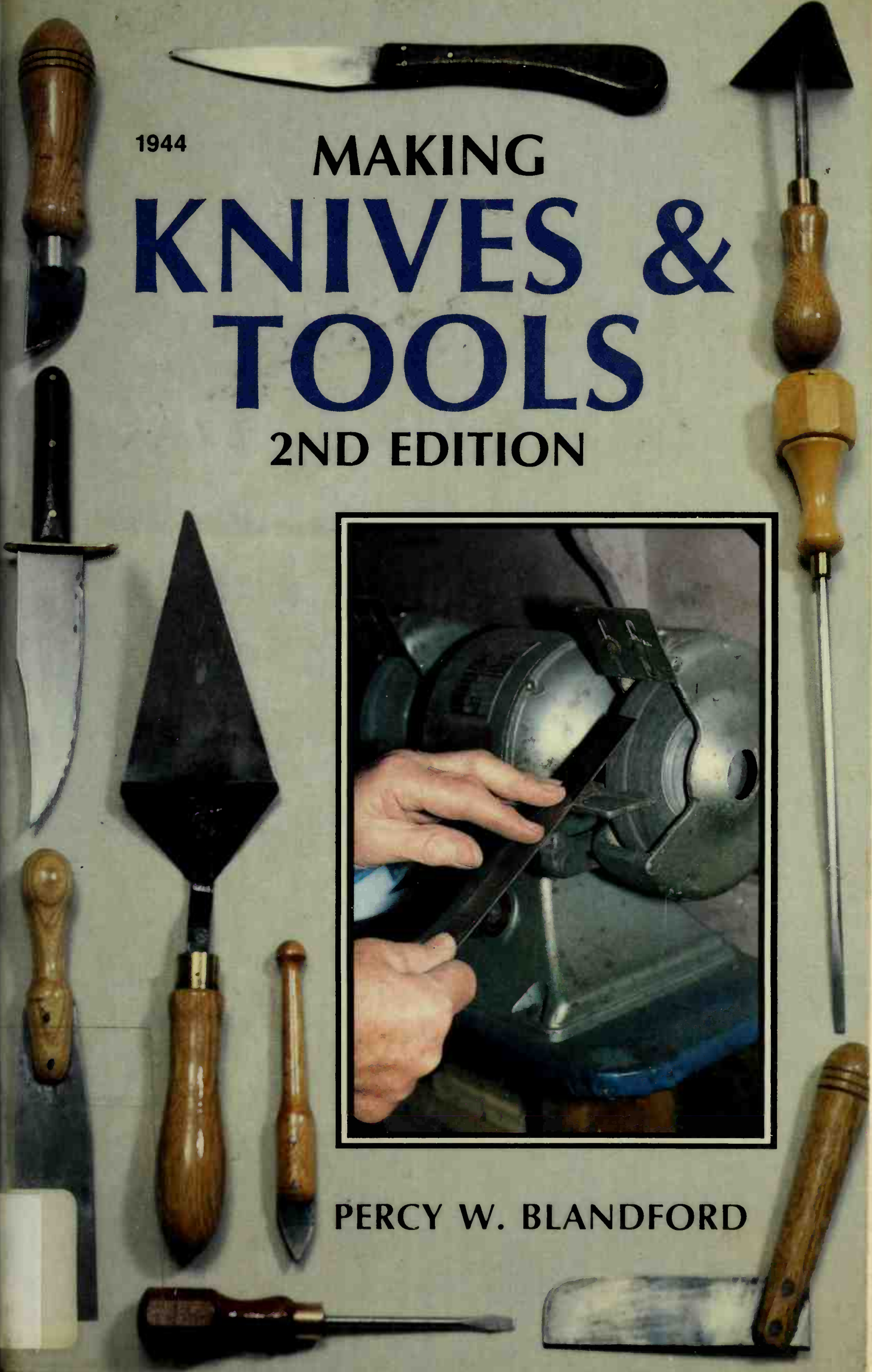

PERCY W. BLANDFORD

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Preface

Why make knives? And why not? Individual workers tackle all kinds of crafts in wood, metal and other materials, either as hobbies or professions. Some of these activities go back to prehistoric times. Man has made knives for as long as he has practiced other crafts, for he has needed them to hunt for food and butcher it when caught, as well as to work skins and fabrics for clothing. Yet the actual making of knives for these activities developed into a specialized skill for comparatively few craftsmen. As with many crafts from the Middle Ages onward, these craftsmen developed their own lore and mystique, so others came to regard the making of knives and associated tools and weapons as trade secrets that required special skills and long training to acquire.

Of course, there is something in that reasoning. Like any other work in wood, leather, metal, and other materials, a skilled craftsman can do better work than one who is less skilled. In any practical work, experience counts, but it is possible for a beginner to soon gain enough skill to make knives and related tools that will be attractive, functional, and as good as the professionally made article. Making simple knives does not require elaborate specialized equipment. Many of the tools will already be owned by a man who has done some metalwork and woodwork. Some knives can be made entirely with hand tools, although power tools lessen labor and make possible some more advanced designs.

As for the mystique and trade secrets—these are no more than found in many other crafts. Metal and wood are worked in similar ways, whatever the craft being practiced. Knives may be offered for sale with allegedly special qualities of temper that make them keep their edge, acquire extra sharpness, or have other qualities. There are a few alloy steels that can be given special qualities with equipment the individual worker would not have, but the majority of knives are made of straight carbon tool steel, and there is nothing that the professional can do to heat-treat the knife he makes that an individual knifemaker cannot also do. If you make your own knife, it can have qualities as good as one you buy.

As with some other crafts carried on by an individual, there is the satisfaction of seeing through the making of something from start to finish. Most of us earn our living doing a small part of some large process. The end product is the result of the work of a large number of people. The old-time craftsman received an order for something, made it in its entirety, and took pride in doing so. A hobby or small manufacturing business gives us a chance to experience something of that pride and satisfaction.

Knifemaking has the attraction of being uncommon. It lets you do something most of your friends will not understand. It allows you to express your individuality. What you make does not have to conform to any mass production design. The knife you produce need be like no other knife that has been made. Even if you make a series of similar knives,they can each have slight differences. To describe a knife as handmade puts it into a special class.

If simple designs and construction are used, it is possible to make knives that show individuality from the start even when all of the work is done with hand tools.

A few knifemaking techniques have to be left to the large manufacturer. These include the various kinds of folding knives. That leaves a very large range of knives and other cutting tools that can be made by anyone willing to learn a few skills, however. That is what this book is all about. Read it and follow the instructions, and you will be able to practice an absorbing hobby, which could develop into a profession. In any case, you will be able to produce knives that will give you tremendous satisfaction, and that you can show to others with pride.

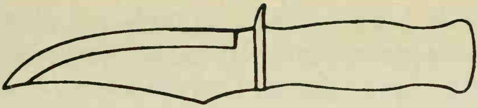
Introduction

The first edition of this book has shown a large readership that knife and tool making need not be regarded as something possible only for the favored few, who have learned the trade secrets. This book has been revised in two main ways, without disturbing all the essential information in the first edition. Many more photographs illustrate techniques and projects, and there is increased emphasis on tools in addition to knives, which can be made by related methods.

New readers may be surprised to learn that anyone with a reasonable knowledge of metal and wood techniques, plus a modest collection of the simpler tools for these crafts, can make satisfactory knives and other edge tools. Materials are not difficult to obtain, either new or from salvaged sources. The actual materials used in a knife or other cutting tool, that would cost many dollars when store-bought, may be salvaged free or cost only cents if new materials are used. Knives and most tools are comparatively small, so there is no need for a large outlay on steel, wood, leather, or plastic.

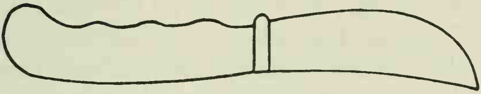
Besides the saving in cost, probably more valuable is the satisfaction of knowing that you made the tool yourself. An individually made item is always more attractive than the mass-produced equivalent. If you wear a knife in its sheath, you have something of which you can be proud and which may be the envy of everyone who sees it.

Read this book and realize you can do it. Assemble some materials; use the tools you probably already have and the techniques you have used for other things. The making of knives and other tools is a less common craft. Use your modest skill and the knowledge obtained from this book to get tremendous satisfaction out of surprising yourself and others by your ability to make what might have been thought only the products of highly skilled specialists. If you want to start a business, there should be a ready market for individually produced knives and small tools that should be superior to many products of large manufacturers.



Chapter 1

Types of Knives



One of the first of primitive man's tools must have been a knife. Long before the discovery of iron and steel, our early ancestors found sharp pieces of rock and used them for hacking their way through meat and other food. In particular, flint was found to break, so it produced cutting edges that were used for knives as well as axes and arrowheads. Many of these early knives would have been used as much for scraping as for direct cutting, but this was the birth of the knife.

EARLY KNIVES

With the ability to extract copper from ore came knives made of bronze. There are surviving examples of Bronze Age knives, as well as weapons and other tools, that show a knowledge of design and an appreciation of fitness for purpose, so many of these very early tools are not vastly different in appearance to modern knives. Of course, bronze is comparatively soft, as it is an alloy of copper mainly, with small quantities of tin and zinc, plus impurities that may or may not have improved the quality of the alloy. There must have been a certain amount of luck involved, but some bronze tools that have been found are hard enough to take a good cutting edge.

The coming of iron made possible the production of knives similar to those we know now. Pure iron is harder than bronze, but still not really hard enough to retain a fine cutting edge for long. Much of the early iron produced would have been far from pure.

The presence of most impurities has a hardening effect, so with luck again, some of those early knifemakers were able to produce an occasional tool much harder than the others.

Steel is iron with a controlled amount of carbon mixed with it. When this is at a certain proportion it allows heat-treatment to get the desired degree of hardness—about which there are instructions in Chapter 2 . The word *alloy* is often used for steel, but an alloy is really a mixture of two or more metals, and carbon is not a metal.

It was the discovery of steelmaking that made the production of all kinds of successful cutting tools possible. These obviously included a large variety of knives of an efficiency never before known. From that stage the technique of knifemaking has changed little in principle. There are greatly improved production methods, but the stages through which steel goes to make a knife are still the same. Only in recent years has what is often called *straight carbon steel* or *tool steel* been joined by steels alloyed with small quantities of other metals to impart special qualities.

A knife needs a handle of some sort. Flint was usually held in the hand, although some specimens appear to have been lashed to wood. Some early metal knives have the handle formed by an extension from the blade. This certainly solved the problem of adding the handle safely. Animal horns were often used. These, and bones, often had holes, into which the end of the blade could be thrust and probably secured with resin or by plugging with wood. The majority of steel knives have wooden handles, but decorative handles can be made with almost all materials, including precious metals inset with precious stones.

Many knives developed from swords and daggers—the blade that killed the animal then became the tool for cutting it up to eat. Weapons are usually pointed and have sharp edges on both sides. Many knives are pointed, but few have double cutting edges. It is safer and stronger to have a single cutting edge, with a thicker back for stiffness. Against that, the knife with two cutting edges can go twice as long between sharpenings.

Knives are still the most generally used tools. Even men and women who make no claim to be craftworkers usually have small pocket knives, and uses are found for them on most days. In a great many practical activities a knife is an essential tool. An occupation may require some very advanced and sophisticated tools, but among them will be at least one knife. Some other tools, such as chisels and planes, may be regarded as special-purpose knives.

Knives vary in size (Fig. 1-1). Most used today are fairly small. In pioneer days there were large knives, such as the *Bowie,* which were used for hunting, butchering, trimming wood, and many other jobs alongside an ax. Knives available today are broadly divided into those that are in one piece and remain rigid, and those that fold. Most of the latter have the blade folding into the handle, with a spring to lock and hold it in the opened and closed positions, but there are other methods of masking the blade when out of use. Many of the rigid knives are used for the preparation and eating of food in the home. These are stored without special protection to the blades, but other rigid knives for outdoor use are given sheaths.

Most folding knives, particularly those generally known as *pocket knives* are unsuitable for making with the equipment in the average amateur's shop, but many types of rigid knives can be made successfully. Some commercially produced folding knives have many blades of different types, all folding safely into the handle. These are examples of skilled and ingenious factor production, and they would be very difficult, if not impossible, to make with simple tools and equipment.

HANDLES

The simplest knife is a plain piece of steel without a fixed handle. This type is still favored by some leatherworkers, such as shoemakers, who bind leather around to make a handle (Fig. 1-2A). A further step from this is to make a handle by riveting wood *slabs* or *scales* on each side (Fig. 1-2B). This and developments of it are the basis of the majority of handles used on modern knives. The part of the steel that goes between the slabs is called a *tang*. If it goes completely through, it is *full tang*. *Slab* is a more appropriate name for the sides of the handle, as *scale* is more correctly one of the dividers in a pocket knife, but this name is also sometimes used for handle parts.

In some knives the tang only goes partway into the handle; it is then called a *half tang* (Fig. 1-2C). Many knives for table use have round tangs that fit into holes in the handles (Fig. 1-2D). These are usually factory produced, but it is possible for an amateur to make them.

Some knives have the handle directly against the blade, but there may be a metal thickening, called a *bolster*, that is often extended to form a *guard* to keep the hand away from the sharp edge of the blade. The guard is a development of the more elaborate

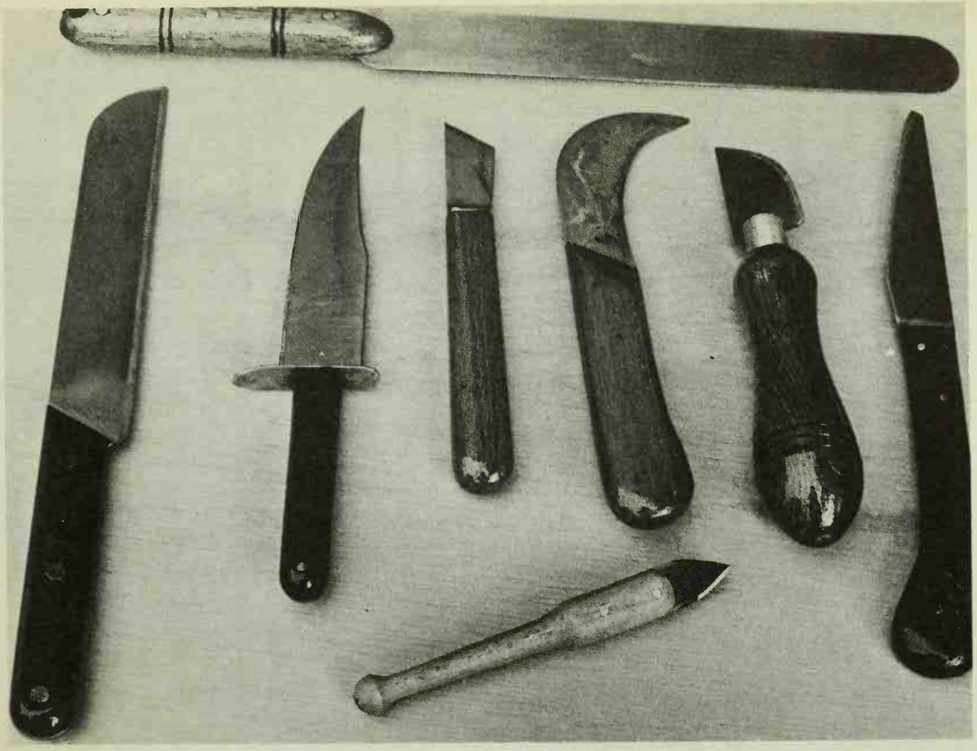


Fig. 1-1. Some of the knives described in this book: top, palette; left to right, kitchen, hunting, marking, hook, leather, utility; bottom, dissecting.

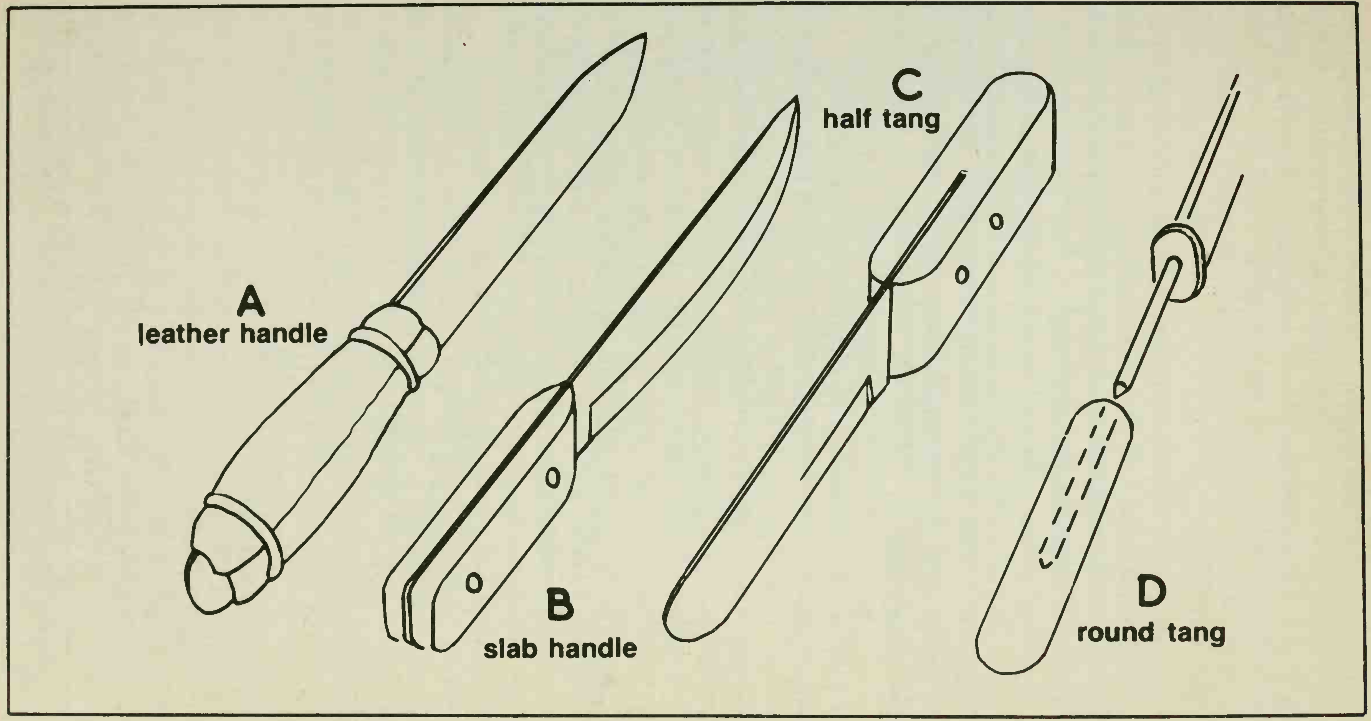


Fig. 1-2. Handles may be leather wrapped (A), slabs on full (B), or half tangs (C), or with a hole for a round tang (D).

hilt on many swords and daggers. Another safety precaution is a *dropped edge*, where the blade is lower than the underside of the handle. This keeps the knuckles away from the surface of a cutting board when the knife is used for chopping.

BASIC TYPES

The basic knife form is often used for a butcher's knife (Fig. 1-3A) in several sizes. The back and edge may be the same width as the handle, the edge may be dropped slightly, and the point is not always arranged in the same way.

A boning knife is a form of butcher's knife with a more slen-

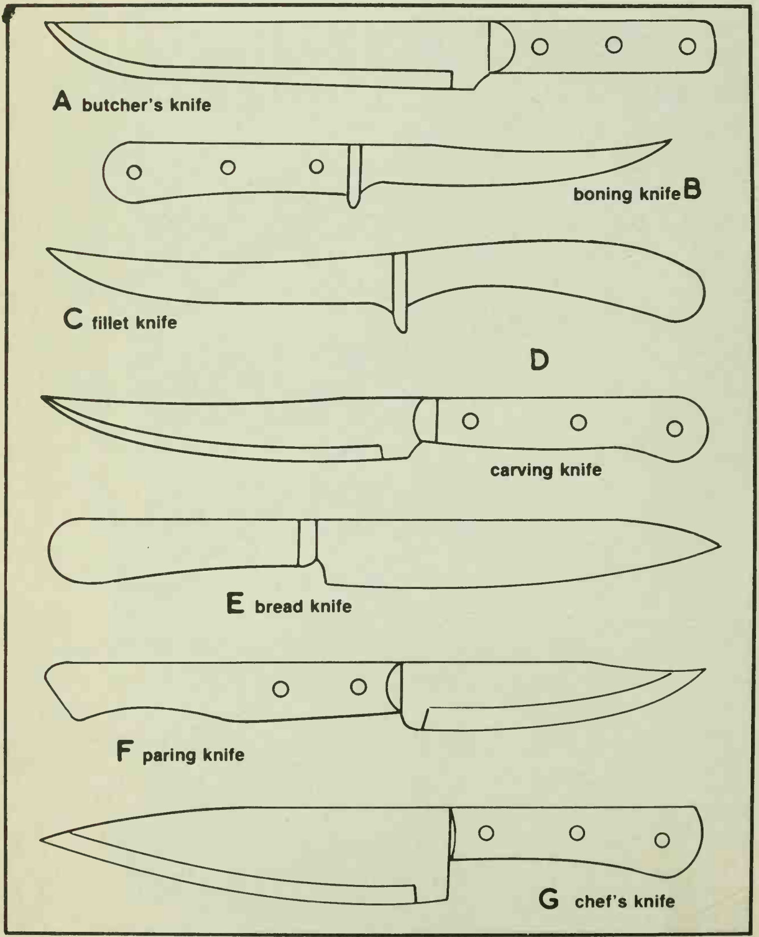


Fig. 1-3. Knives are shaped to suit particular purposes. These are for dealing with food.

der blade that curves upward a little at the point (Fig. 1-3B). As the blade is narrower than the handle, a guard is advisable.

A fillet knife (Fig. 1-3C) has a form very similar to a boning knife, but the blade is thinner and more flexible. Some blades are very narrow, and a new knife may give the impression of being worn away with age.

Carving knives (Fig. 1-3D) are really special versions of butcher's knives intended for use on the dining table. Some are elaborately finished and may have decorated handles, but as they have to do similar work to that of a butcher cutting meat on a block, they are basically the same.

A bread knife (Fig. 1-3E) is very similar in general form to a carving knife. Many factory-produced bread knives have serrated or sawlike edges, but an individually made knife has a straight edge and relies on its sharpness. Edges are dropped to give hand clearance when cutting through to the board.

A variety of small knives have uses in the kitchen and elsewhere, and these may be collectively called *utility* or *paring* knives (Fig. 1-3F). Usually the blade is no longer than the handle and some may be shorter. The blade can be slender, dropped edge, or quite wide in relation to its length. Curved handles look attractive and give a comfortable control to a light knife.

A chef uses a knife slightly bigger than a paring knife, with a broad pointed blade (Fig. 1-3G) for preparing and chopping vegetables. This is stiff, but taken to a thin cutting edge. The blade edge has more curve than the back, and it is used to chop or slice on a cutting board, starting at the point and lowering the handle.

That type of chopping is more of a press, but if the knife is intended to be swung to get a heavier blow, the blade is widened so it has some of the weight and action of a hatchet (Fig. 1-4A). The handle has a swell at the end to prevent the hand from sliding off. A meat cleaver (Fig. 1-4B) is similar, but heavier—the weight usually coming from a larger and thicker blade in relation to the handle.

Not every knife has a handle on the end. One type of chopping knife has a curved blade and the handle comes above it (Fig. 1-4C). An Eskimo ulu is similar (Fig. 1-4D). It was used for skinning, but it would make a good chopping knife. A saddlemaker, and other leatherworkers, traditionally us a knife with a sharp semicircular edge (Fig. 1-4E). The edge is pressed and rolled on the leather and can follow a curved or straight line.

An outdoor man, whether he is a camper, hunter, fisherman,

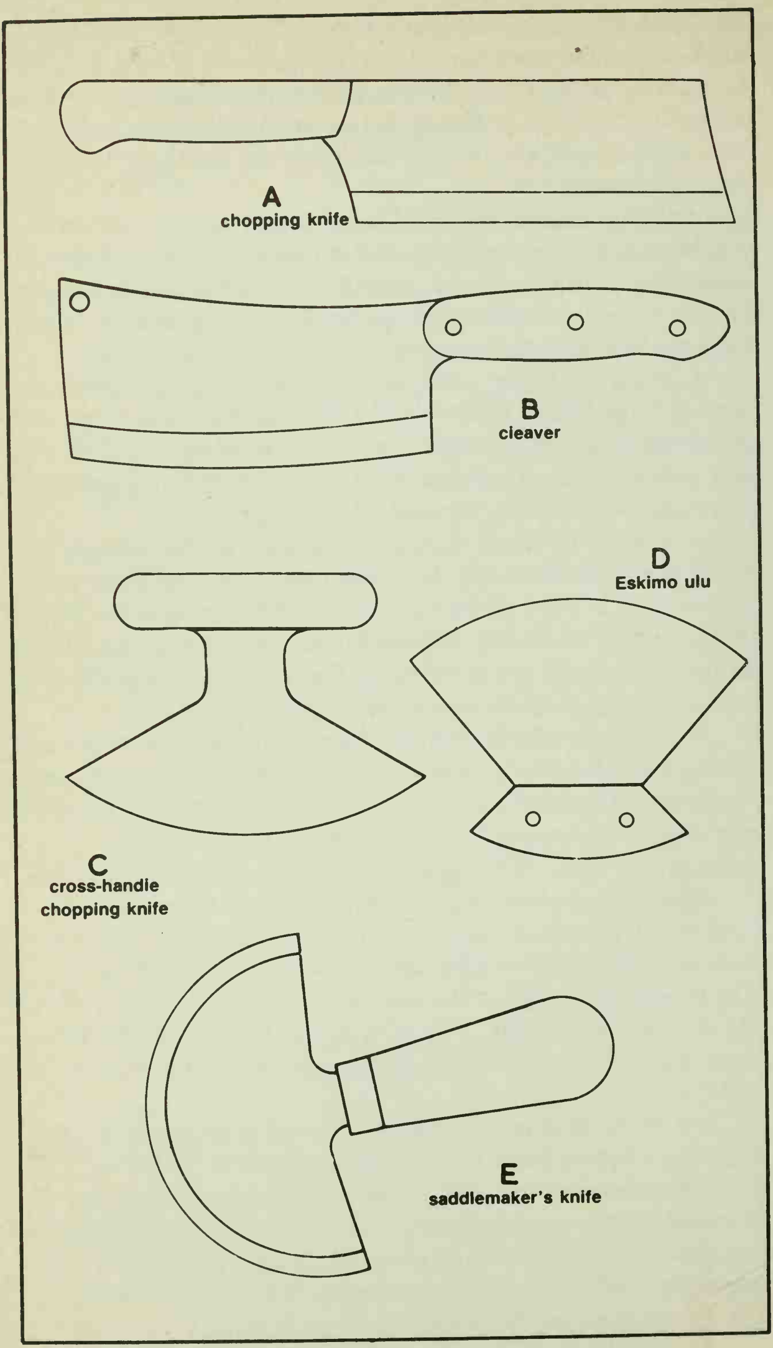


Fig. 1-4. Knives can be made to chop or cut with a rocking motion.

or other sportsman, likes to have a substantial general purpose knife, usually in a sheath on his belt. These knives take a variety of shapes. Some handles are built up of wood or leather for the grip and have ends made from several metals and plastic to give an attractive shape and pattern. Some of these knives, based on hunting knives, have quite thick backs and blade sections that would be difficult for an amateur to make, but most of these knives can be made satisfactorily, and much interest can be gained from producing individual shapes and special patterns in the handles.

One type has a barrel-shaped handle, a knob at the end, and a guard that does not extend very much, behind a blade that tapers in thickness and has two hollows along the back (Fig. 1-5A). Sizes vary considerably. Very large knives seem to attract owners, but an overall length of 8 inches or 9 inches should be more than enough for most modern needs. If the knife is for skinning, the blade may be shorter than the handle and given a curved-up point (Fig. 1-5B), but usually the blade is longer than the handle. If there is no reason

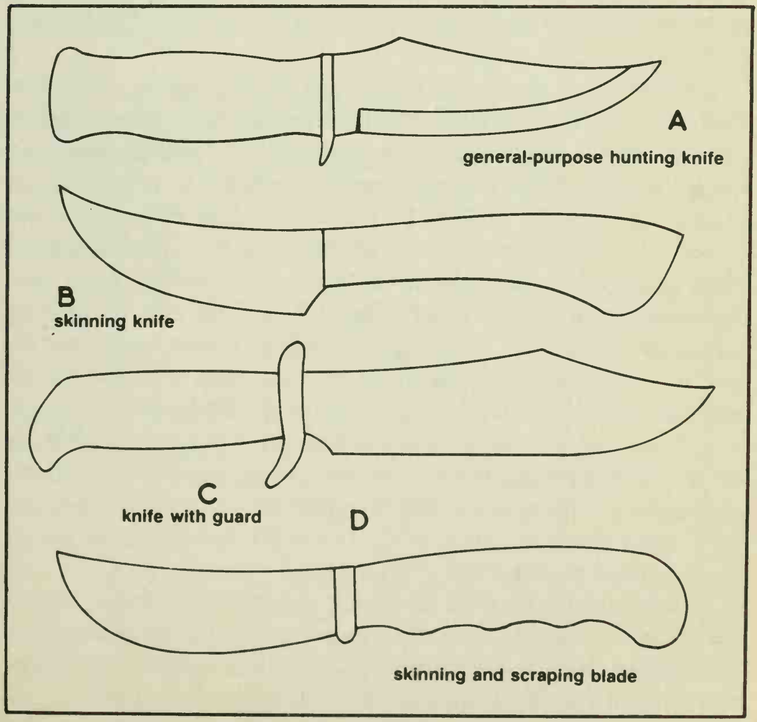


Fig. 1-5. Knives for hunting and skinning have broad blades with shaped handles usually having finger guards.

for making it otherwise, this gives a better looking knife, which will whittle wood, fillet fish, cut meat, and serve most cutting needs about camp.

Some sheath knives are given guards that are more like those for a dagger (Fig. 1-5C). They may be attractive to some owners, but a large guard, particularly at the back, is not really necessary. Any knife that is to be used for skinning will have to be used for scraping as well as directly cutting. This is helped by giving it a deep curved sweep behind the point (Fig. 1-5D).

The way the knife will be sheathed has to be considered. Most knives taper toward the point. This design allows a neat shape for the sheath and easy entering and withdrawing (Fig. 1-6A). If the blade is broader toward the point—as it would be if to be used like a machete for slashing, the sheath has to be wide and loose at the top (Fig. 1-6B) so that the end of the blade will pass.

If there is a guard, the enclosed part of the sheath has to stop at that. The handle is held by a strap, usually secured with a snap (Fig. 1-6C). This is satisfactory, but if the strap is accidentally released while the sheath is on a belt, there is a risk of its turning over and the knife falling out.

If there is no projecting guard, part of the handle can follow the blade into the sheath (Fig. 1-6D). The sheath then hangs below the belt and there is no risk of its inverting accidentally. Seamen's knives, which are like plain butcher's knives, are usually sheathed in this way. A knife dropped from aloft would be very dangerous.

The tip of a blade is nearly always pointed. The majority of blade designs have a slight curve to the back and the edge with more curve up to the point (Fig. 1-7A). This has a pleasing appearance and suits most needs. Outdoor knives and some for kitchen use have part of the back straight, then a hollow *clip* toward the point (Fig. 1-7B). This lightens the blade when the back is thick for stiffness and produces a finer point. It is better for some knives, such as bread knives, for the cutting edge to be straight, or almost so. The back can also be straight, with a slight taper and curve down to the end (Fig. 1-7C). It is safer for some table knives to give them rounded tips (Fig. 1-7D).

If a blade is to be used for paring toward the operator, it is an advantage to have the blade wider and stronger toward its end. This is described as a *sheepfoot* blade (Fig. 1-7E). A compromise blade, with more of a point but still stronger toward the tip than the normal point, is a *spey* blade (Fig. 1-7F).

Pocket knives are made so that they are very similar to rigid

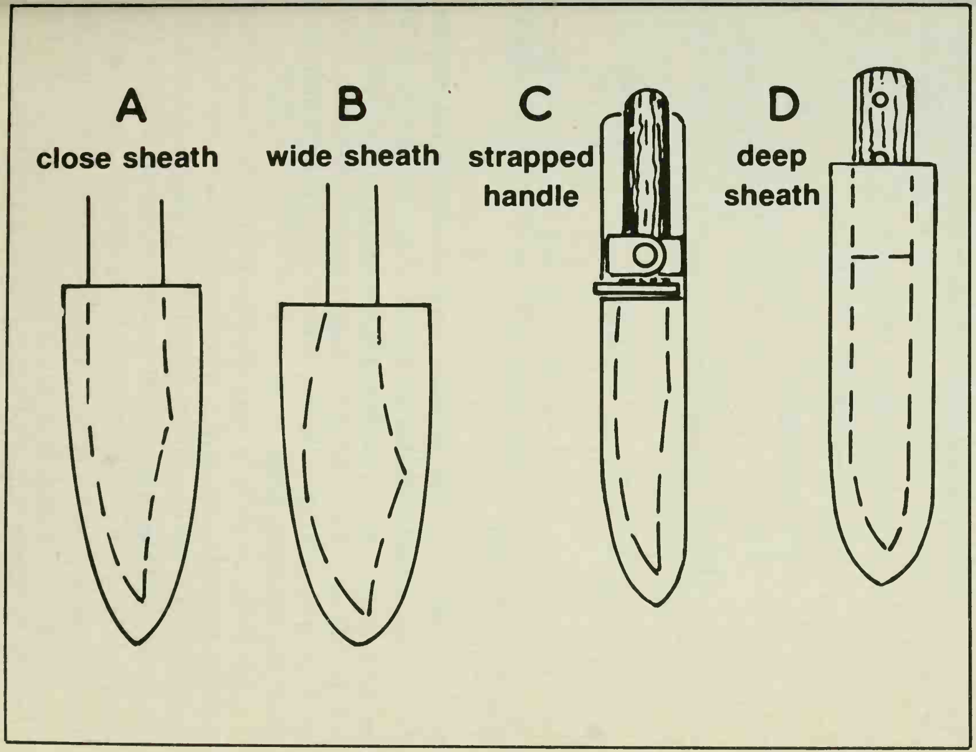


Fig. 1-6. Sheaths have to allow the blade to slide in and out easily. A strap or a deep fit prevents the knife from falling out.

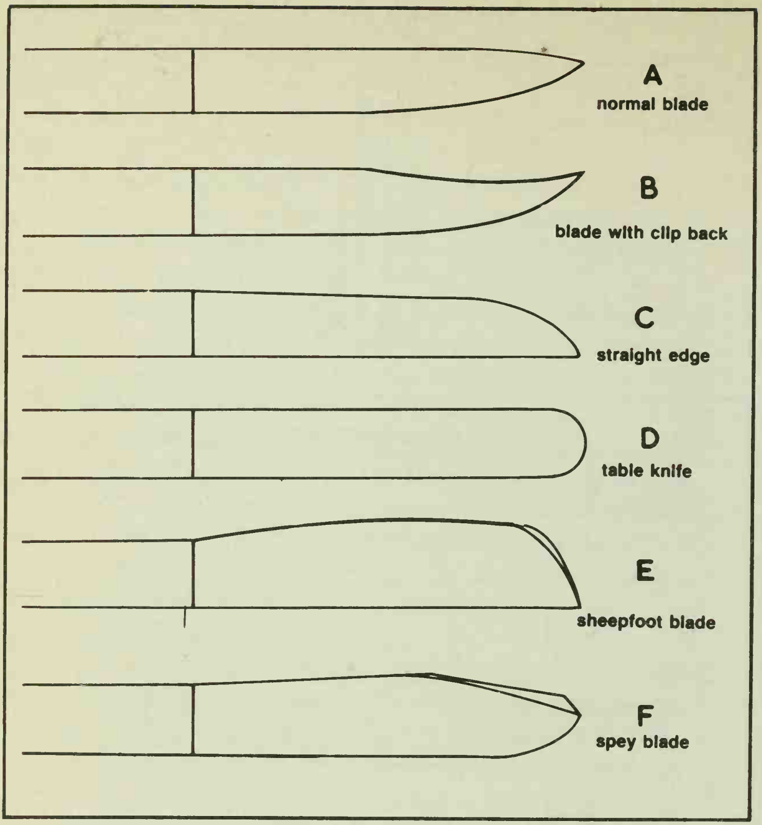


Fig. 1-7. The end of a blade may be pointed for a forward cut, or it may be wider for a pulling cut.

knives in their open form, but many are much smaller and intended for nothing rougher than sharpening pencils or peeling fruit. In the simplest form there is a single blade. It can have any of the usual shapes, but for pocket use the straight edge of a sheepfoot blade or the near-straight spey blade will be easier to sheath within the blade and therefore safer.

The blade pivots on a steel pin (Fig. 1-8A). There is a spring between two metal side scales, which may then have sides of horn or plastic fitted for appearance (Fig. 1-8B). The spring is held between the scales with rivets, but its end toward the blade is free to move in and out. The part that bears against the blade is called the *blade walk.* The blade tang is shaped so that when the knife is open the spring end goes into a shaped part (Fig. 1-8C) and prevents the blade from moving in normal use. As the blade is closed, the spring bends outward against the curved end of the tang (Fig. 1-8D), but as the blade drops into the handle, the shape allows the spring to go in again and hold the blade in place (Fig. 1-8E). The back of the blade stands a little above the handle when in the closed position, and a grooved *nail mark* (Fig. 1-8F) can be used to pull the blade out again.

Two blades, arranged at opposite ends, can be controlled by one spring pivoting on a central rivet. If there are more than two blades, they have to come in different spaces divided by more scales.

The making of the parts of a pocket knife calls for work of greater precision than would be required for any nonfolding knife, and the hardening and tempering of the springs as well as the blade would be difficult to do accurately with the facilities normally

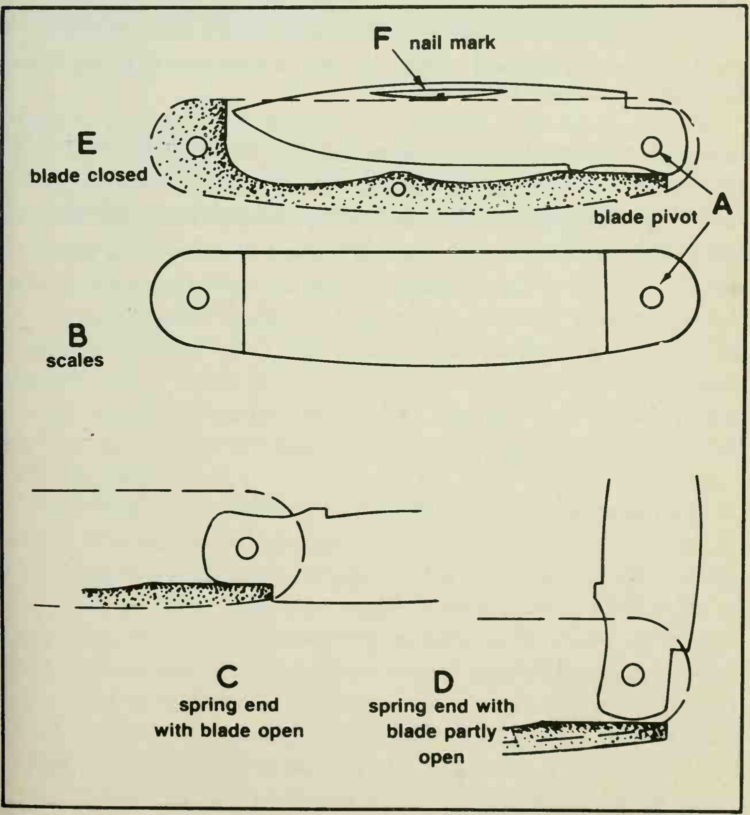


Fig. 1-8. A folding pocket knife has a spring (shaded portion) to keep the blade secure in closed and open positions.

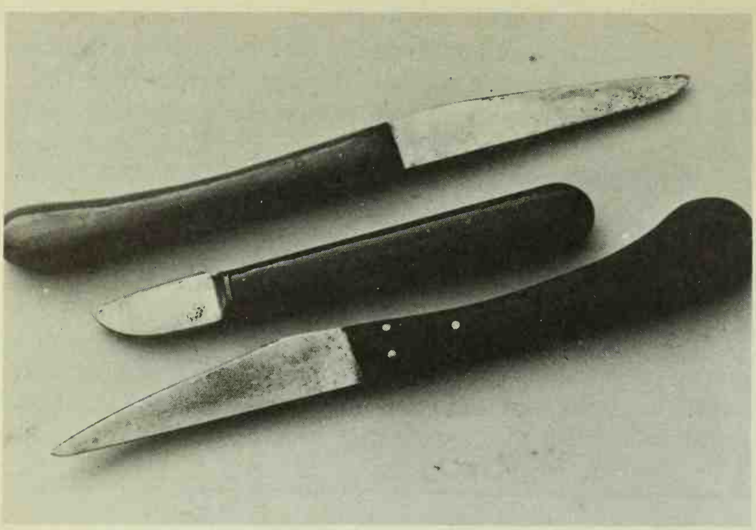
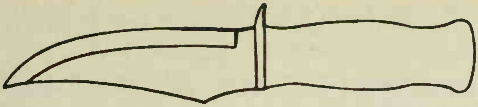


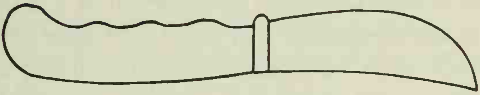
Fig. 1-9. Examples of simple knives: the center one cut from a table knife and the others made from steel sheet.

available to an amateur. Consequently, it is advisable for the reader to consider the making of rigid knives only (Fig. 1-9) at least until he has gained considerable experience and maybe acquired more advanced equipment.



Chapter 2

Steel



There is no alternative to steel for a modern knife blade, but many other materials can be used for handles and sheaths. Suitable steel is much harder than any of the other materials, and it is the ability to work steel that controls the extent to which a knifemaker can go. Some knives can be made with quite simple equipment, but for some types the shaping and heat-treatment must be done with more advanced tools and facilities. In general, it is safe to assume that if the steel in a selected knife can be dealt with, there should be no difficulty in working the wood, plastic, and other metals that will be needed to make the handle. Leather for sheaths needs different tools, but it is much easier to work than the materials that form the knife.

The quality of steel and its behavior under heat-treatment is mainly affected by its quantity of carbon. This is quite a small proportion, but it is carefully controlled during manufacture. If the proportion is quite low, the result is *mild steel.* Today, this is sometimes referred to incorrectly as *iron*, as its qualities are not very different from pure iron. Pure iron is better for blacksmithing and is favored by the smith for things like decorative ironwork, but for ordinary structural metalwork, mild steel is what the ordinary person speaks of as ironwork.

Mild steel is unaffected to any appreciable extent by heat-treatment. It cannot be hardened. It is possible to anneal it (soften it) slightly. Mild steel is of no use for knives or other cutting tools because any edge worked on it would collapse as soon as an attempt was made to cut with it.

Unfortunately there is no easy way to distinguish mild steel from tool steel by sight. If it is salvaged metal, its previous use may show what it is. If it was part of some assembly or structure, it is mild steel. If it was used for springing or cutting in some way, it is tool steel. With new steel in a long piece, mild steel will be found to bend and stay bent whereas tool steel, even in its softest state, will resist bending and feel more springy. Old saw blades must obviously be tool steel. Car springs would not work if mild steel, so they have possibilities in knifemaking. If there is doubt about the type of steel recovered from a scrap yard or other source, an attempt at heat-treatment will show mild steel as unaffected, but tool steel will show the changes described later in this chapter.

Besides *carbon steel* or *tool steel*, which is the straight iron and carbon mixture, there are many steels with quite small quantities of other metals added. They are collectively known as *alloy steels*. The additional, usually rare, metals give special qualities, such as durability, but mostly they are various *stainless steels*. The word *stainless* is only relative. No steel will resist corrosion under all circumstances. Some stainless steel will remain unaffected in the common conditions that would cause ordinary steel to rust. Unfortunately, the alloyed metals in much earlier stainless steel also affected its hardening qualities, so many stainless steel knives did not retain good edges as long as plain steel ones could, and stainless steel as a toolmaking alloy got a bad name. This defect now appears to have been corrected, and it is possible to get stainless steel knives that combine resistance to rust with good cutting qualities.

Alloy steels are almost all unsuitable for heat-treatment with the facilities that are available in most amateur's shops. There has to be a more precise control of temperature, which can only be achieved in factory conditions. Consequently, amateur knifemakers should use only plain carbon steel.

Many things are made of carbon steel, and they provide a source of supply. Saws for woodworking, ranging from those for hand sawing to those used in sawmills for converting logs to boards, are nearly always straight carbon steel. They are discarded when no longer suitable for their purpose, but they still have considerable areas of steel that can be made into knives. Metalworking saws today are almost always alloy steel, so they are unsuitable. Even the small disposable hacksaw blade is alloy steel and not worth attempting to use for a knife. Springs of most kinds are carbon steel. The larger leaf springs may be too thick for many knives, but they can be made into chisels and hatchets or other heavier cutting tools. Worn-out files are another source of thicker carbon steel.

If new steel is bought, it may be sufficient to ask for straight carbon steel. However, your supplier may be more familiar with many other classifications. Steel for saw blades may be described as L6. AISI or W2 are other plain tool steels. New steel may be in strips, described by its width and thickness. The thickness may be by measurement, but thinner material is given a gauge number. The lower the number, the thicker the metal. As a very rough guide, 8 gauge is not very far from $\frac{1}{8}$ inch and 16 gauge is close to $\frac{1}{16}$ inch. Anything thinner than 20 gauge is unsuitable for knives. Thicknesses are more easily understood if given in decimals of an inch, but a micrometer is needed if you want to test them.

It is also possible to get carbon steel in square and round rods. Some tool dealers sell these, often in 13 inch lengths, when they do not stock other forms of tool steel. They may be described as *silver steel*, which does not mean any special alloy, but indicates a good quality carbon steel, usually with a bright surface and accurate to size. Although these may not be the cheapest supply of steel, they provide a convenient source for early experiments and the making of pointed tools, small chisels, and screwdrivers.

HEAT-TREATMENT

Most metals and alloys are affected by heat-treatment. The effect differs among them and has to be dealt with accordingly. For instance, what hardens steel would soften copper. In knifemaking we are mainly concerned with steel, so steel is discussed first.

Three things can be done to steel by applying heat: annealing, hardening, and tempering. What happens within the steel can be the subject of lengthy scientific discussion and has no place here. We are concerned only with the practical aspects. New carbon tool steels may be described by their carbon content. Table 2-1 shows working temperatures that should be applied where equipment with heat indication is available.

Steel, or any other metal, is annealed when it has been relieved of internal stresses and is as soft as it can be made. New carbon steel is usually supplied in a fully annealed state, although some steel intended for particular commercial uses may be already tempered to suit. Usually the supplier will indicate that the steel is annealed. We need steel to be annealed for all the preliminary

Table 2-1. Heat Treatment Temperatures.

Carbon content	Forging	Annealing (slow cool)	Normalizing (air cool)	Hardening (quench in water or 10% brine)	Tempering (as required)
.70%	1000°C	750°/ 780°C	800°C	780°/ 810°C	100°/300°C
	1830°F	1380°/1435°F	1470°F	1435°/1490°F	212°/570°F
1.00%	950°C	750°/ 780°C	800°C	760°/ 800°C	100°/300°C
	1740°F	1380°/1435°F	1470°F	1400°/1470°F	212°/570°F
1.10%	950°C	750°/ 780°C	800°C	760°/ 800°C	100°/300°C
	1740°F	1380°/1435°F	1470°F	1400°/1470°F	212°/570°F
1.25%	950°C	750°/ 780°C	800°C	760°/ 780°C	100°/300°C
	1740°F	1380°/1435°F	1470°F	1400°/1435°F	212°/570°F

work of shaping and drilling—in fact, much of the work could not be done otherwise.

If the carbon steel has already been used for a saw or spring, it will have to be annealed. It may be cut with a torch into suitable sizes for handling, but it would resist drilling, sawing, or filing. In some cases, such as an old file, it may be very brittle and attempts to work it could break it.

ANNEALING

Annealing is done by heating to redness (cherry red) and allowing to cool as slowly as possible. How this is done depends on facilities. A blacksmith heats the steel in his coke or coal fire then leaves it there until the fire has gone out and the steel is cool enough to handle. This takes several hours and is a clue to what is required if heating is by another method. If a kiln, such as is used by potters, is available, the steel may be heated in the kiln and allowed to cool with it.

If heating is by a propane torch, it would be unsatisfactory to merely hold the steel in the air to heat and cool because it would lose temperature too quickly. Instead, the steel should be in a bed of coke or asbestos blocks among fire bricks that surround it and reflect heat back on to it. When an even redness has been reached, the whole set-up is left undisturbed until cold. Within reason, the longer that cooling takes, the softer the steel will be. Do not hurry the process—it is best to leave it overnight.

Fortunately, the annealing temperature is not critical and is best observed in daylight. Some forms of artificial light may affect the appearance, but the correct color is fairly easy to judge. If a kiln or other heater with a temperature gauge is available, it is probably best to do a trial heating, observe the arrival of a cherry red color, and then note the temperature reading, which will be in the region of 1000° F. (800° C.). A domestic cooking oven has some uses in other heat-treatment, but it cannot reach a sufficiently high temperature for annealing.

The word *normalizing* is sometimes used to mean annealing, but it is particularly applied when the process is done to reduce internal stresses after the metal has been worked by forging and bending. These stresses do not occur in the making of most knives. It is the same treatment, but in relation to knifemaking it is better called annealing.

HARDENING

Hardening is done by heating the steel to redness and cooling it quickly. For a simple pointed tool, a propane torch or other source of heat can be used to heat the end for a short distance to a full red heat, while the end away from the point is held by tongs. If the tool is lowered quickly and vertically into a container of water, the important part of the tool will be hardened without much risk of anything going wrong. With broader tools, such as knife blades, a few precautions should be observed if results are to be successful.

With a knife there is no need to harden the tang, but the treatment of the blade needs to be even. The length of the blade should be brought to the same bright red, while tongs are used on the tang. If a kiln is used with a pyrometer or temperature gauge, this is around 1450° F. Heating can be by a coal or coke smith's fire, with the knife in a rack, but if a torch is kept moving about, it is possible to get the desired even heating.

The method of cooling can affect the steel in many ways, as well as harden it. Cold water makes the steel harder than warm water but very rapid cooling may cause surface cracks. Tepid water (60° F.) is about right, if water alone is used. Uneven heating of a blade may cause warping, which will not be apparent until after cooling. Turning the blade over during the heating can even internal stresses that cause warping.

Hardening will discolor the steel, but the problem of getting it clean again after heat-treatment is less if it starts with a smooth surface, not necessarily highly polished. Quench soon after reaching the correct temperature. Prolonged heating will allow impurities to enter the pores of the steel, which are open when it is hot. Use clean heat so that there is less risk of impurities coming near the steel.

Hardening by cooling in water is the traditional way and often satisfactory, but it is wiser with the usually thin-sectioned knives to quench in another solution. None of these will give the same degree of hardness, but as the next step (*tempering*) is withdrawing some of the hardness, an initial maximum hardness is not essential.

Brine (salt and water) makes a good cooling bath that conducts heat away quickly. This solution should be saturated—as much salt dissolved as the water will take. Sal ammoniac can be used, but common salt is more readily available.

Oil is more usual for quenching steel for knives. Special quenching oils can be bought, but several oils can be used. Obviously, it would be dangerous to use an oil that might burst into flame if red hot steel were thrust into it. It is possible to use old crankcase oil, but olive oil is cleaner.

A brine bath may be simply a large bucket. If some of the contents are spilled or made to spray over as the hot steel enters, it may not matter. It is advisable to keep oil within bounds and be more economical. The oil may be in a container that is suspended in a bucket of water (Fig. 2-1A), so spilled oil is trapped by the water, which will also quell any flames.

Although an end-cutting tool may be lowered vertically into the quenching bath, it is better to lower a knife in horizontally with

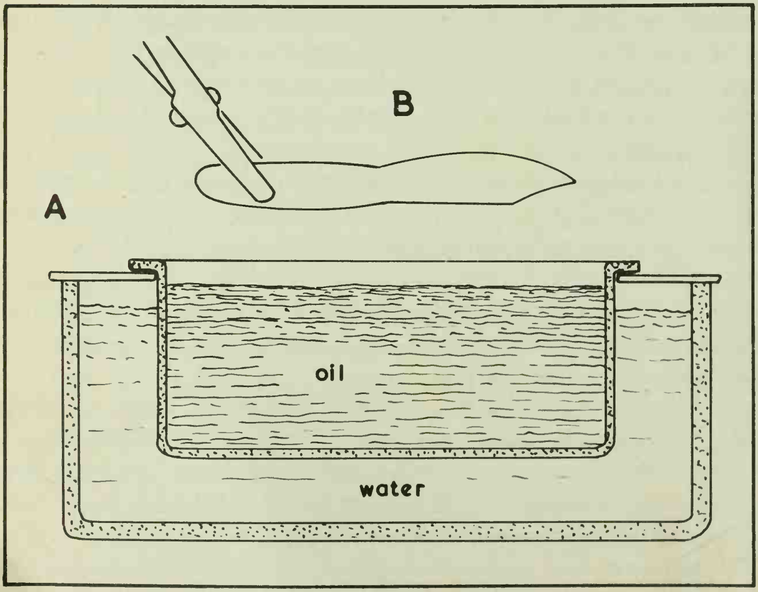


Fig. 2-1. Steel being hardened can be quenched in various liquids, including oil, which should be surrounded by water.

its edge upward (Fig. 2-1B). This reduces the risk of distortion. Move the blade up and down in the oil, until it has obviously cooled. Vibration may be felt in the tongs for 10 seconds or more. Do not remove the knife until vibration has ceased. If only one blade is being treated, there is no risk of overheated oil affecting hardening, but if a succession of knives are to be dipped, have enough oil to dissipate the heat, or the quenching bath may get too hot to do its job properly. A knife held horizontally should be able to be lowered at least 6 inches into the bath.

An older type of quenching bath uses water as the main coolant, but oil is allowed to float on the surface. This could be olive oil, mineral oil, or even thick grease. When the hot steel is lowered through this surface film, it gathers a layer of grease that slightly retards cooling by the water. This is claimed to produce a tough steel with freedom from the risk of cracks.

TEMPERING

Hardened or *refined*, carbon steel is not only hard, but it is also brittle. There are few uses for fully hardened steel. A knife in this state would soon break, or the edge would chip in use. Some of the brittleness, and with it some of the hardness, has to be taken out by tempering. This is a further heat-treatment at a lower temperature.

Although the temperature is important, there is a very useful guide to temperature in the colored oxides that form on the surface of polished steel. The colors are just that; they play no part in the treatment of the steel. The oxides may be cleaned off. Removing the wrong color, however, does not right the mistake!

If a piece of steel has been worked smooth before hardening, it can be rubbed bright fairly easily with emery cloth or other metal-cutting abrasive paper. An alternative popular with smiths is a flat piece of sandstone. If the colors of the oxides are observed as heat is applied slowly, the first is a pale straw, which deepens to an orange and brown, continuing to a reddish brown until deepening into a blue, before going on with further heat to become red hot. The temperatures these oxides represent go from about (430 ° C.) at the straw color to 500 ° F. (260 ° C.) for the deep brown and 580 ° F. (300 ° C.) for blue. Knives are right at the middle of the range, with a medium brown for most purposes.

The higher the tempering temperature, the softer does the steel become (Table 2-2). When the desired temperature is reached, the knife is plunged into the cooling bath that was used for hardening.

Table 2-2. Tempering Heat.

Approximate temperature Fahrenheit	Centigrade	Oxide color	Tools
430	220	faint straw	engravers, metal scrapers
445	230	straw or orange	saws
475	245	deep straw or brown	scribers, knives, punches
520	270	bronze	knives, chisels
550	285	purple	cold chisels
570	300	blue	screwdrivers, springs

Figure 2-2 gives an idea of the oxide colors as observed in daylight, but it should be treated as a guide only.

As an experiment in hardening and tempering, the end of a piece of carbon steel rod, about $\frac{1}{4}$ inch square or round, that has

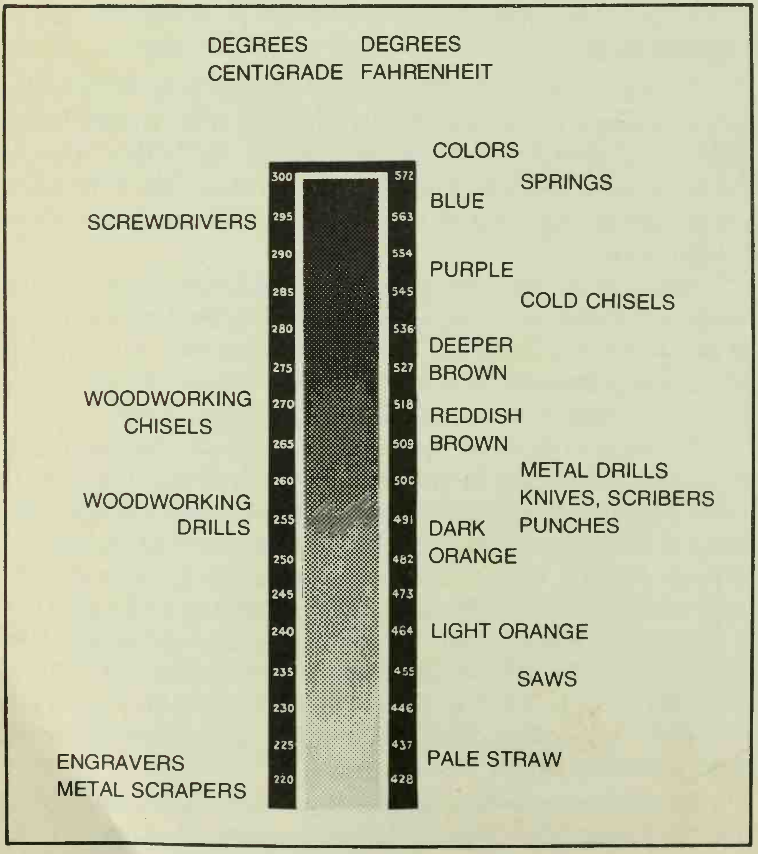


Fig. 2-2. Steel tempering chart.

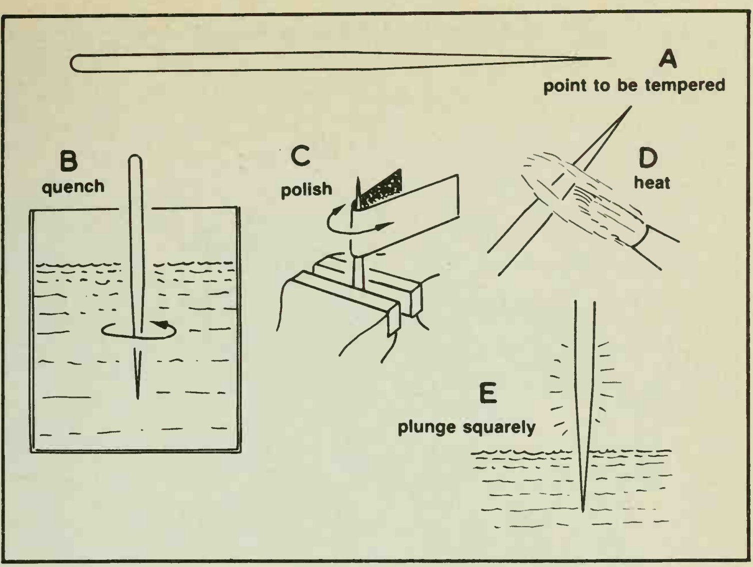


Fig. 2-3. An end-sharpened tool is hardened by being quenched vertically after heating to redness. The steel is rubbed bright and heated away from the end and quenched when the appropriate colored oxide has reached the end.

been annealed can be filed to a long tapering point to make a scriber (Fig. 2-3A). This will be useful in marking knife shapes. Get the taper smooth with emery cloth. Heat the end to redness for about 1 inch and plunge the point into water (Fig. 2-3B). Keep it moving until it is cold. Polish the tapered part with emery cloth, but do not treat it too roughly, or it may break (Fig. 2-3C).

Use a torch to heat the steel about 2 inches back from the point (Figs. 2-3D and 2-4). Do this gently, moving the flame and frequently removing it. The heat from this part will travel toward the point, even when the flame has been removed. Watch the polished surface. The straw-colored oxide will be seen to move along and eventually spread until it meets the point. On the thinner metal it will move quicker. Farther back it deepens to yellow and brown. As the point turns pale brown, plunge the scriber into the water again. The colors will still be there when you withdraw it. They can be polished off. The scriber is ready for sharpening and use. It will be at the correct temper for up to $\frac{1}{2}$ inch from the point. Farther back it will be softer, as indicated by the higher range of colors. If it ever gets sharpened that far back, it will have to be hardened and tempered again.

It is possible to harden and temper an end-cutting tool in one

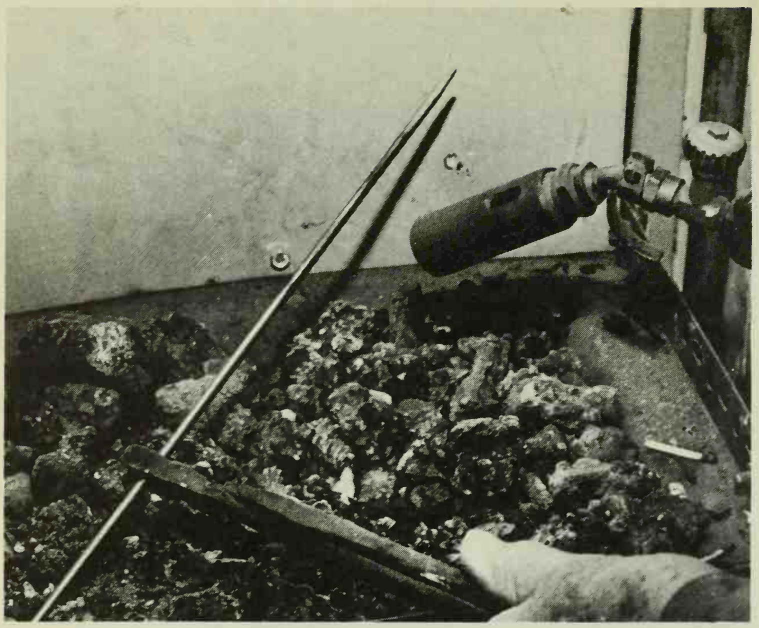


Fig. 2-4. Use the flame of a torch a few inches back from the end when tempering.

heating instead of the two just described, and this was the smith's usual technique. The scriber, or other tool, starts with a smooth surface, and the point is heated for hardening. It is then lowered into the quenching bath only enough to cool the point (Fig. 2-3E). While still held by the tongs, the part about 2 inches from and toward the point is quickly rubbed bright with a piece of sandstone. There is still plenty of heat in the body of the tool, and this heat travels toward the point. As before, the oxide colors are watched and the tool quenched when the correct color reaches the point.

Of course, knives need even tempering all along the blade, and the method of watching oxides spread from one point does not work because this would lead to uneven tempering in the length.

The best way to temper knives is in a kiln with a temperature gauge. The knife, or several knives, are supported near the center of the space. Slots in fire bricks can be used. But be sure most of the steel is exposed, not buried in deep slots. The temperature to aim at is 450 ° F. for most knives, although it can be taken a little farther for a knife likely to get rough treatment and benefit from being a little softer. The brittleness associated with hardness must be remembered, and increased toughness of an edge has to be accompanied by some loss of hardness. When the correct temperature has been reached, the knife is taken with tongs on the handle and quenched. Although the handle as well as the blade will have been raised to the tempering heat, because it was not previously hardened, it will be unaffected by the treatment, although the same oxide will appear there.

By careful work it is possible to temper a knife with a torch flame, but it is difficult to get the same degree of temper along the blade. It is inadvisable to attempt this with a narrow blade as progress of the colored oxides may be too swift to control. With a blade more than about 1 1/4 inches wide for most of its length, this method is possible.

Polish the blade after hardening. Use tongs or pliers to hold the tang. Have the quenching bath ready nearby for quick action. Use a fairly small flame and keep it moving with a fanning action along the back of the blade (Fig. 2-5). Do not let it approach the cutting edge, and do not heat the point as much as the rest of the back of the blade. Frequently withdraw the flame and examine the polished surface. Colors will move from the back toward the edge,

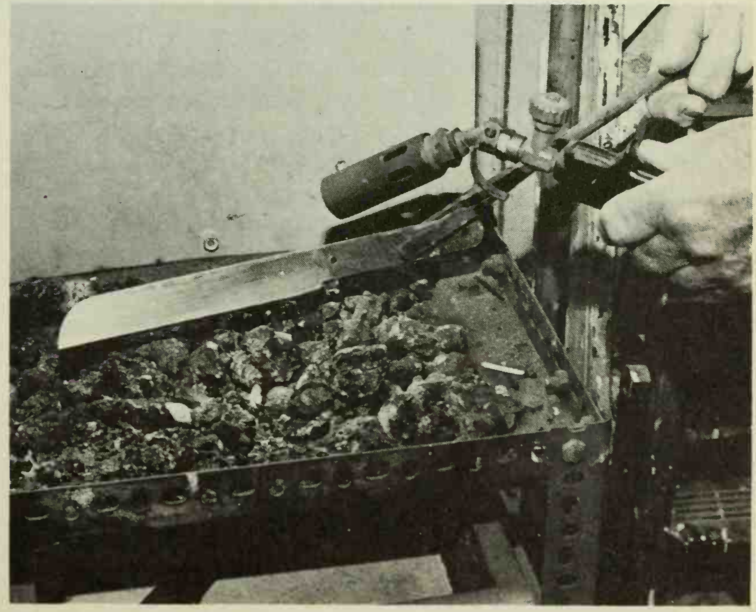


Fig. 2-5. A wide blade may be heated for tempering by fanning a torch flame along its back.

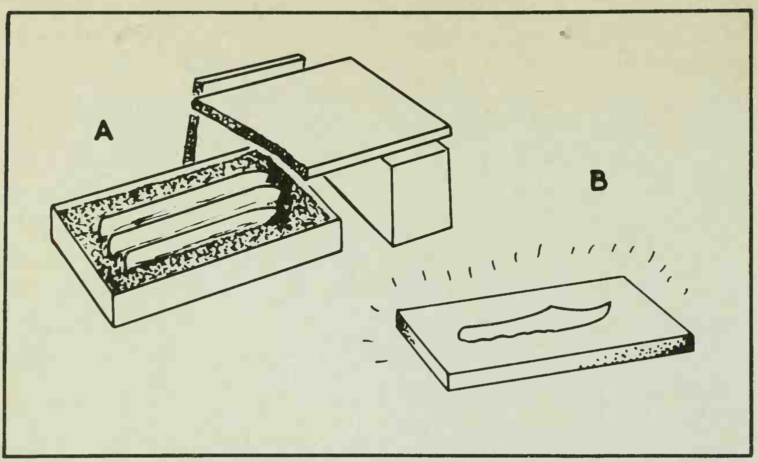


Fig. 2-6. Knife blades may be tempered by heating in coke or on a hot iron plate.

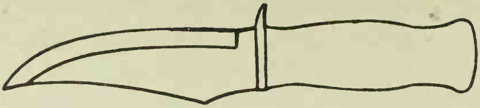
and when the appropriate point has been reached, quench quickly. This method produces a blade that is softer and, therefore, tougher and stronger along the back, which is an advantage where the blade will be hit, as in a froe and a hacking knife.

It is better to support the knives in a tray over a flame. Powdered coke could be used in the tray, which should be a sheet metal box bigger all around than the largest knife. It might be possible to use pieces of asbestos or just a single piece of asbestos. This is mounted over a source of heat. It could be a smith's forge fire, although the twin burners of a camping range would do and be cleaner. Above the assembly there should be a sheet of asbestos supported on fire bricks to reflect heat back (Fig. 2-6A).

The knives should be supported so that their cutting edges are upward and most of their blade area is visible. Then colors can be easily observed. Once the critical stages are being approached, it would not affect tempering if a knife were lifted out with tongs to inspect the oxide color.

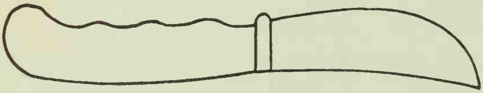
Another older method practiced by a smith uses a piece of thick steel or iron plate. This is heated just to redness and then moved to the side of the fire. The steel to be tempered is laid on it, so heat is transferred by conduction. As the plate temperature is more than that required for tempering, the heat will transfer, and the oxides can be watched (Fig. 2-6B).

If it is found that the oxide colors have been allowed to go too far in any method of tempering, it is necessary to go back to the hardening stage and start again. Letting the colors go too far will mean too much hardness has been lost, and rehardening will be necessary. If tempering is stopped too soon by quenching before the required color has been reached, it is possible to heat again and continue past that point to the one wanted, but it would probably be wiser to reharden and temper again. Tempering twice after one hardening, each going to the same limit, is sometimes done to ensure full tempering.



Chapter 3

Other Materials



The main part of any knife has to be steel, but handles are made of a great many materials (Fig. 3-1). Bolsters and guards are usually metal, but the part of the handle that is gripped can be wood, leather, plastic, or metal (Fig. 3-2). Some handles are built up with many layers of different materials. Sheaths are usually leather, but they can be plastic, and some have wooden interiors.

METALS

Of the metals, brass and copper are the most common. Brass is an alloy of copper and zinc. In its purse state, copper is a soft and ductile metal. Other metals are added to it to harden it or give other qualities. Zinc to make brass is the commonest alloy. Bronze is an alloy of copper and tin, sometimes with small quantities of other metals. The color is more golden than the usual yellow of brass. Brass with a high proportion of copper in the alloy is ductile, but when the zinc content is increased, although machining qualities are improved, the metal is more brittle.

Aluminum is another soft metal in its pure state. Most commercial aluminum is far from pure, and most aluminum available is actually alloyed with other metals in small quantities, mostly to harden it, although some are for increasing resistance to corrosion. Most aluminum alloys do not machine well.

In making handles there will usually be little need for heat-treatment. Copper and brass cannot be hardened by any heat-

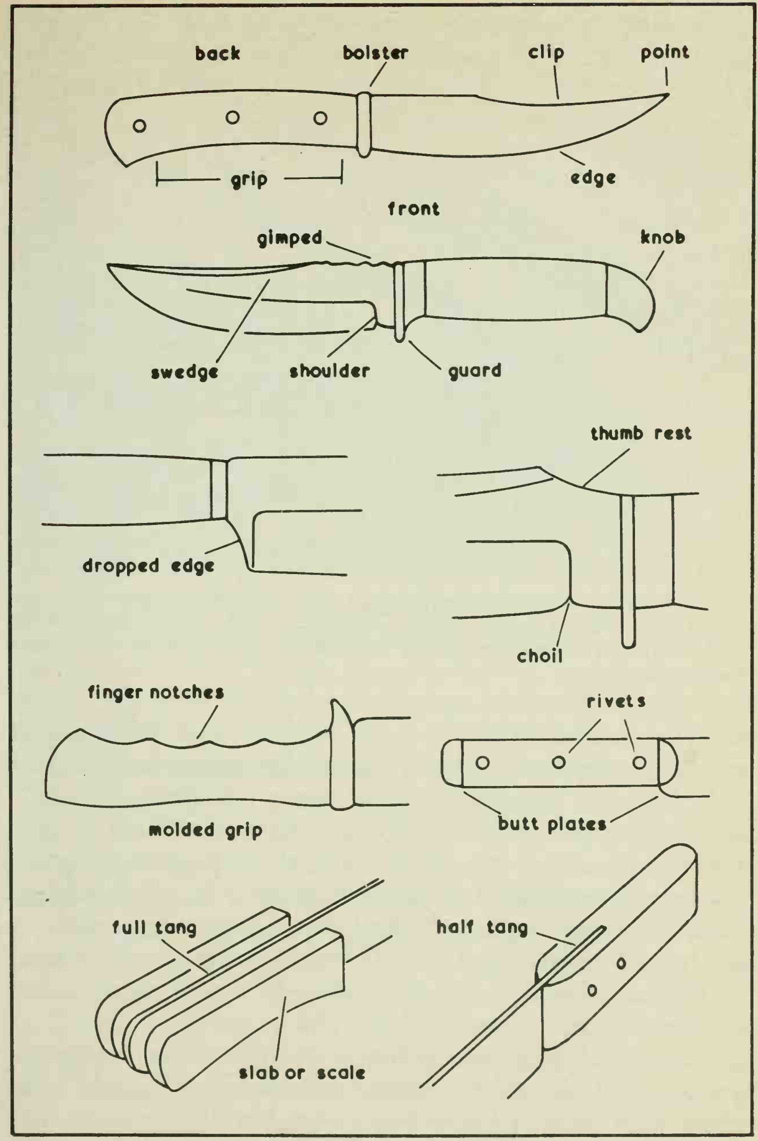


Fig. 3-1. The main parts of a knife.

treatment, but they work-harden. If they are hammered or otherwise worked, as in machining, they gain considerably in hardness, even to the stage of becoming brittle. Copper sheet that is hammered becomes hard. If hammering is continued, it will crack.

If copper becomes hard, it is annealed by heating to redness

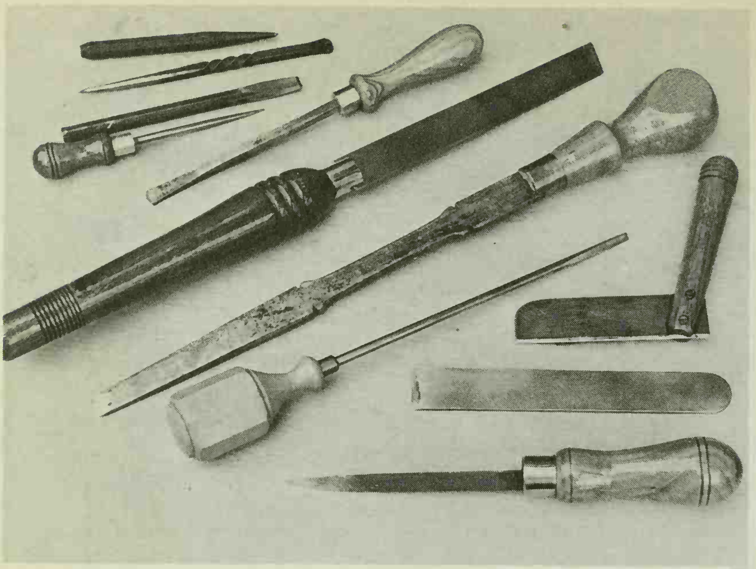


Fig. 3-2. Many tools besides knives can be made by similar processes. Those shown (from left) are punch, scriber, cold chisel, awl, scraper woodturning chisel, large screwdriver, electrician's screwdriver, froe, wood chisel, and triangular scraper.

and either cooled quickly in water or left to cool. Brass is also annealed by heating to redness, but if cooled quickly there is a risk of cracking, so it is better left to cool slowly. Aluminum also work-hardens, but this is unlikely to be a problem in knifemaking. If it has to be annealed, the amount of heat required is not great. Overheating would spoil the metal. A guide to the amount of heat is to rub the surface with soap and then heat the aluminum over a flame until the soap turns back. It is unlikely the zinc will be used, but if it has to be annealed, this is done by immersing the metal in water heated to about 200° F.

Copper and brass become discolored after cooling in air or water. In large-scale heat-treatments, quenching is in an acid bath, so the metal is cleaned as well as cooled, but this needs care and special facilities. For the small pieces of metal used in knifemaking, it is simpler and safer to scour the surface clean with pumice or domestic scouring powder and a damp cloth, followed by polishing. Polishing alone may not remove all the discoloration, except by vigorous application.

Rivets are made of these nonferrous (i.e., noniron) alloys. As supplied, they should be soft, but to a limited extent they age-harden, and working can be improved by annealing them before use. Brass screwed fastenings will be of the more brittle high zinc alloy content, which is better for machining. It is inadvisable to attempt to anneal this.

WOOD

Much of the attractive appearance of many knives is due to the wood used in the handle. The amount of wood is quite small and a knifemaker gets an opportunity to use what would be thrown away as offcuts in many other woodworking occupations. In fact, the attraction of some handle woods is in the difficult twisted grain that causes another craftsman to discard the wood.

The enormous variety of woods available is divided broadly into hardwoods and softwoods. The names do not truly describe the relative hardness of every wood, as there are some softwoods harder than some hardwoods. Hardwoods come from trees that shed their leaves in the winter. Softwoods are mainly from the coniferous trees with needles rather than leaves. Softwoods are unsuitable for knife handles. The harder close-grained woods make the best handles. Some hardwoods may be hard, but the grain form shows visible spaces. This occurs in oak, ash, and chestnut. It is better to use woods that do not show gaps, as they are less likely to splinter and they will take a better finish.

For most knives the common wooden handles are a dark color. This is normally the natural color of the wood, but stain can be used. A problem with using stain is that later wear may penetrate any protective polish, and some of the stain will be rubbed away to lighten the color. Oil stains penetrate the grain. Water stains are more likely to remain near the surface. Light-colored hardwoods are acceptable for some knives, particularly those associated with food, as they have a more hygienic appearance.

There is a considerable amount of sap in a tree when it is growing, even in the winter when sap is at its minimum and when most felling takes place. Some of this moisture has to be removed before the wood is suitable for use. The drying process is called *seasoning.* At one time seasoning was done naturally, with boards stacked between spacers and one year allowed for every inch of thickness, but modern methods are much speedier.

Despite this seasoning, it is a good idea to store any wood intended for handles a few months before using it. This allows the moisture content to settle to an acceptable level. Wood that is still too wet will shrink and warp or split open—all of which could be a nuisance and spoil appearances if they happened after the wood is made into a knife handle.

A stock of pieces of wood cut to not much bigger than the finished sizes of handles can be kept on a shelf in the shop and drawn on as needed. They should then settle to a stable size and shape much better than if they were cut from a larger piece just before being made into a handle. For slab handles the pieces can be in double thickness and cut down the middle for use.

ADHESIVES

There are many glues for joining wood to wood. For a knife handle it is advisable to use only those described as waterproof. These can be used if different pieces of wood are to be joined to make a laminated pattern handle. The best types are those sold for boat building.

None of the woodworking glues make a satisfactory bond between wood and metal, but epoxy glue can be used to bond wood to wood and wood to metal, as well as metal to metal and most other materials. This is useful to supplement rivets in joining handles to steel tangs as well as for building up parts that may be in mixed materials. As with any other adhesive, it is important that the meeting surfaces should be chemically clean. In particular any grease on the metal should be removed with a solvent. It helps to roughen the meeting surfaces with coarse abrasive paper.

Epoxy glue is in two parts, which have to be mixed just before use. The strongest glue is rather slow setting and needs to be left several days to reach full strength. There are quicker types, described as *5-minute epoxy* or something similar, which sacrifice some strength for speedier results.

Other *instant* adhesives should be checked to see which materials they suit. Some are not suitable for porous materials, like wood.

SOLDERS

The strongest way to join the harder metals is by welding, using an oxyacetylene torch. A similar torch can be used to burn steel to shape or to burn holes in it. The snag with this is that the flame temperature is so high that it affects the steel and locally heat-treats it in a way that may not be wanted. It may undo the heat-treatment already given. There are uses for such a torch, as described later, but for joining a metal bolster to a knife, or similar work, it is better to use a method that requires only heat lower than that which could affect the characteristics of the steel.

Three methods of joining metals can be used. The one requiring the least temperature and producing the least strength is *soft soldering*. Soft solder is a lead/tin alloy, usually supplied in sticks or wires. With it there has to be a flux. It is possible to make up a flux, but it is more convenient to buy a prepared liquid or paste flux. The surfaces must be mechanically cleaned, but heat would oxidize them. The flux prevents this and helps the solder to flow. A propane torch can be used to heat the metal in the direction the solder is to flow. Quite a small amount of heat will draw soft solder through a joint.

Soft solder does not produce much strength, but if a joint is a reasonable fit and the layer of solder thin, it will be strong enough for a bolster. The melting temperature is above that of boiling water, so washing the knife will not break the joint, but if the knife is heated very much higher the joint may part.

A stronger joint is made with silver solder. This is a copper and zinc mixture, to which a small amount of silver has been added. Borax powder can be used as a flux, but there are more convenient prepared liquid fluxes. The flattened end of a piece of $\frac{1}{8}$-inch iron wire is needed to use as a spatula for pushing the flux into place.

The heat required is considerably more than that needed for soft soldering, but some silver solder flows at less than the tempering heat of steel, so using it with care should not affect a knife that has already been hardened and tempered. The finished joint is much stronger than soft soldering.

The strongest joint, except for welding, is *brazing*, which is done with *spelter*. Spelter is a brass rod with its alloy of copper and zinc arranged to give the lowest possible melting point, but this is much higher than that of silver solder. The heat needed to make spelter flow is about the tempering heat of a knife blade, so brazing has to be done with careful use of the flame so no part of the blade gets too hot. Except for the higher temperature the method is the same and with the same flux as for silver soldering. Although spelter flows at a lower temperature than the melting point of the brass likely to be used for a bolster, it is not much lower, so in addition to watching that the blade temper is not drawn, the possible melting of a brass bolster has to be guarded against.

A skilled worker may regularly use brazing, but silver solder is the best choice for most metal joints in amateur-made knives. Soft solder can be used when temperatures have to be at a safe level and great strength is not required.

Aluminum is the one metal that cannot be joined with these methods. If aluminum parts are to be included in a handle, it is best to arrange for them to be held by sandwiching between other parts or by rivets.

PLASTICS

The variety of plastics produced is very large. Not many of them are suitable for knife handles, although some not very satisfactory types have been used in the handles of commercially produced cheap knives.

Vulcanized fiber may be rubber-impregnated, but most of it uses synthetic rubber or plastic. This is a suitable material to alternate with metal to build up a pattern in a handle. Thicker pieces with cloth laminated in resin can be used instead of wood for the main parts of handles. If is possible to impregnate wood with epoxy resin to make a very hard and waterproof material for handle grips.

Handles for table and kitchen knives may be plastic, usually in the form of rods with the round tangs in holes. Many of these plastics are made to look like ivory, tortoise shell, and other attractive natural materials.

Most solid plastics are stable and can be worked in similar ways to wood and metal. Many of them can be softened with heat—usually with boiling water or a slightly higher temperature in an oven. This allows them to be manipulated to shape, and it is possible to force a tang into a slightly undersize hole, so the plastic shrinks to grip it.

BONE

Many old-time knifemakers used bone and horn for handles. This may have been because there was usually a hole down the center that made an obvious socket for a tang. Deer horns made handles for light knives. Sections cut lengthwise would make slabs to go one on each side of a tang. They were often used as the sides of pocket knives.

Bone may be carved. Ivory and whalebone can be whittled fairly easily. Besides simple bone handles, the materials can be used by artistic craftsmen to produce highly individual handles. Many bone or horn handles offered on bought cutlery today are actually very good plastic copies.

The holes in bones and horns are unlikely to fit knife tangs very closely and a strong joint is obtained by bedding them in a mixture of epoxy glue and wood or bone sawdust.

LEATHER

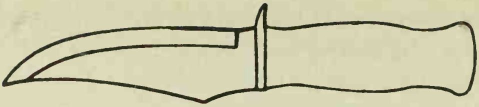
Leather for a knife sheath should be fairly stiff. Do not use light fancy leathers that are made into decorative items where flexibility is an advantage. A sheath should keep its shape. If it tends to twist on a belt, it could be dangerous. Another problem with soft leather is that the knife blade may cut into it or reach the stitches and cut them. The usual sheath leather is cowhide, fairly heavy grade and of good quality. It may be described as French-tanned or oak-tanned. The grade is specified by weight, and 7 ounce or slightly heavier will suit most knives. This is a leather nearly $\frac{1}{8}$ inch thick. Similar leather or some slightly thinner and more flexible can be used for straps.

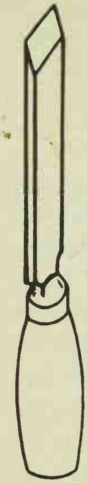
Even if the whole piece is not to be dyed, cut edges will have to be treated to give an even appearance. Use a special leather dye, not wood stain. Thread should be the strong type sold for shoemaking and heavy leatherwork. It will be waxed, but it is worthwhile having a ball of beeswax available to draw the thread through before use. This helps to make the thread stay put as you sew and waterproof it.

Epoxy glue will stick leather, but it is not flexible after it sets. The alternative is the glue usually sold as cobbler's cement or adhesive.

In most sheaths thread is all that is needed, but a heavy-duty sheath may need a few reinforcing rivets. These are bifurcated; the heads are flat, the necks are solid, but the ends are divided, to be spread after passing through the leather.

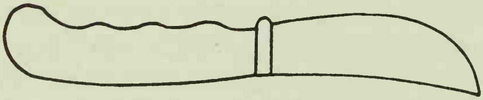
Some sheaths have leather thongs instead of thread binding the edges together. It is possible to cut thongs yourself from scrap leather, but they can be bought from craft shops, either in leather or colored plastic, which can be used for special effect.





Chapter 4

Tools



The knives we make are steel. Many of the tools we use are made of steel. This means that any tool work on knife material is being done with material that is only relatively harder because of the difference between annealed and hardened and tempered steel. It may be a lesson in the effect of these heat-treatments, but it means that too much should not be expected too quickly from using steel tools on steel. It also shows that it is no use trying to use steel tools on steel that has not been annealed. Of course, some tools benefit by being made of alloy steel that may gain something in hardness, but relative hardness is still not very different.

There will have to be some work with files and saws and drills, but fortunately there are other pieces of equipment that can be used. Heat can be used for cutting. Abrasive grits can also be used for cutting and shaping as well as for sharpening. An amateur making just a few knives may have to do much of his work by hand, but even then it may be possible to get the use of other facilities for certain processes. Anyone wanting to make more knives may acquire the other equipment, which can also be used in making many other things besides knives. It is possible to make just a few knives with extremely little equipment, but the work is faster, accuracy may be more easily obtained, and satisfying results are produced with a few special items of equipment.

CUTTING

The first problem is cutting steel to shape. If new carbon steel is bought, it will nearly always be supplied in a fully annealed state. This can be cut with a sharp hacksaw. The blade should be of an alloy steel and have very fine teeth. It is important that several teeth are cutting at any time. Coarse teeth might span the thickness of the steel. Attempts to make them cut would cause the saw to jump and break. Fine teeth, down to 32 per inch, might not do much better if taken straight across thin steel stock (Fig. 4-1A). Cutting is much better if the saw is used at an angle to the surface (Fig. 4-1B) so that several teeth are in contact.

It is also important to reduce vibration. A piece of thin steel standing up in a vise and being sawn across some way from the vise will vibrate, so saw teeth blunt or become broken. If the steel is in a vise, the cut should be quite close to the jaws. It may be easier to clamp the steel flat over the edge of a bench (Fig. 4-1C).

With any tools used on steel, it is important to keep them cutting. If saw teeth merely rub over the work, their sharpness will rapidly disappear so that after only a few strokes they become ineffective. This means that hand sawing should be done with deliberate strokes carrying enough weight to ensure cutting. Too much weight on some very hard alloy saw blades may shatter them.

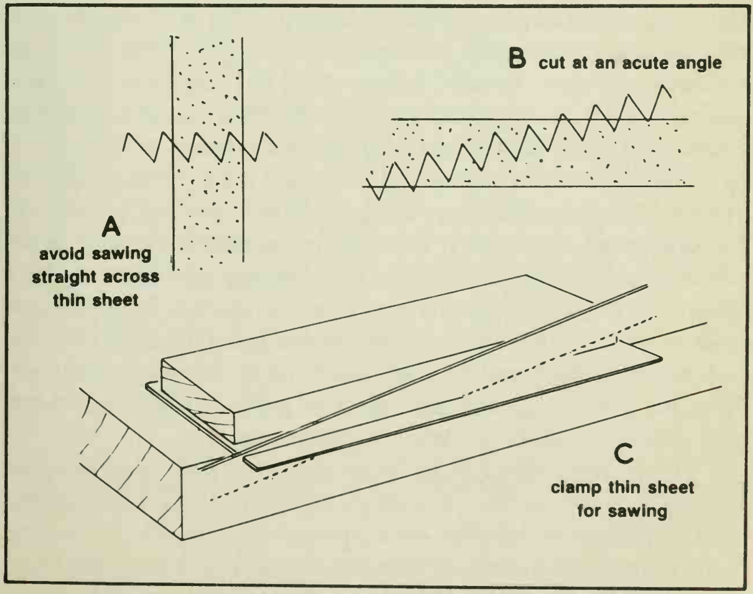


Fig. 4-1. Sawing should be done with as many teeth in contact as possible. A diagonal cut, particularly on sheet metal, ensures the maximum number of teeth being in action.

You will soon know what is happening at the teeth by the feel of the tool as you handle it. Another effect of letting a tool rub instead of cut is local hardening of the steel so that it resists future attempts at cutting.

There are power tools for cutting steel. A bandsaw is one of them, but it is insufficient to try to adapt the usual woodworking bandsaw by fitting a metalworking blade. A woodworking saw runs much faster than is acceptable for steel. A bandsaw is very useful for cutting wood and some other materials for handles, but if it is to be used for cutting steel for blades, it needs a fine metalworking blade that runs at no more than 150 feet per minute. At about three times this speed, the same blade will cut brass, copper, and aluminum, but its normal speed for wood is about 100 feet per minute. The majority of bandsaws with built-in motors cannot have their speed reduced sufficiently. If the drive comes from an independent motor, however, it may be possible to step down the speed with suitable belts and pulleys.

A grinder is not much use for the first cutting of steel to shape from a large piece, but it has possibilities. One source of supply of steel is large mill saws, either band or circular. There are many tree-felling saws around and other steel things that have outlived their usefulness and have been discarded. They still contain good steel, even if considerable rust has to be removed. These old things are nearly all good straight carbon steel, but they were hardened and tempered. A saw would not touch them, but they could be reduced to small pieces that could be annealed.

The steel is hard enough to break off if it can be thinned. This can be done with a grinding wheel, preferably one that has not had its edges worn very round. The steel is brought to the edge of the wheel and a groove ground (Fig. 4-2A). Getting steel down to about half-thickness allows you to snap it in the groove. If you cannot do it in your hands, holding close to the groove with a vise and bending backward and forward a few times will make it break. Grinding in this way will not follow an outline closely, but it lets you reduce the steel to sizes you can manage.

The grinding wheel, in its simplest form, is a wheel on an arbor that fits into the chuck of an electric drill (Fig. 4-2B). One or a pair of wheels may be mounted on a pedestal (Fig. 4-2C). A common arrangement has a pair of wheels mounted on each side of an electric motor (Fig. 4-2D). The usual type has the wheels rather close to the motor (Fig. 4-3). For work on knives it would be better if they extended (Fig. 4-2E). A portable wheel that can be moved

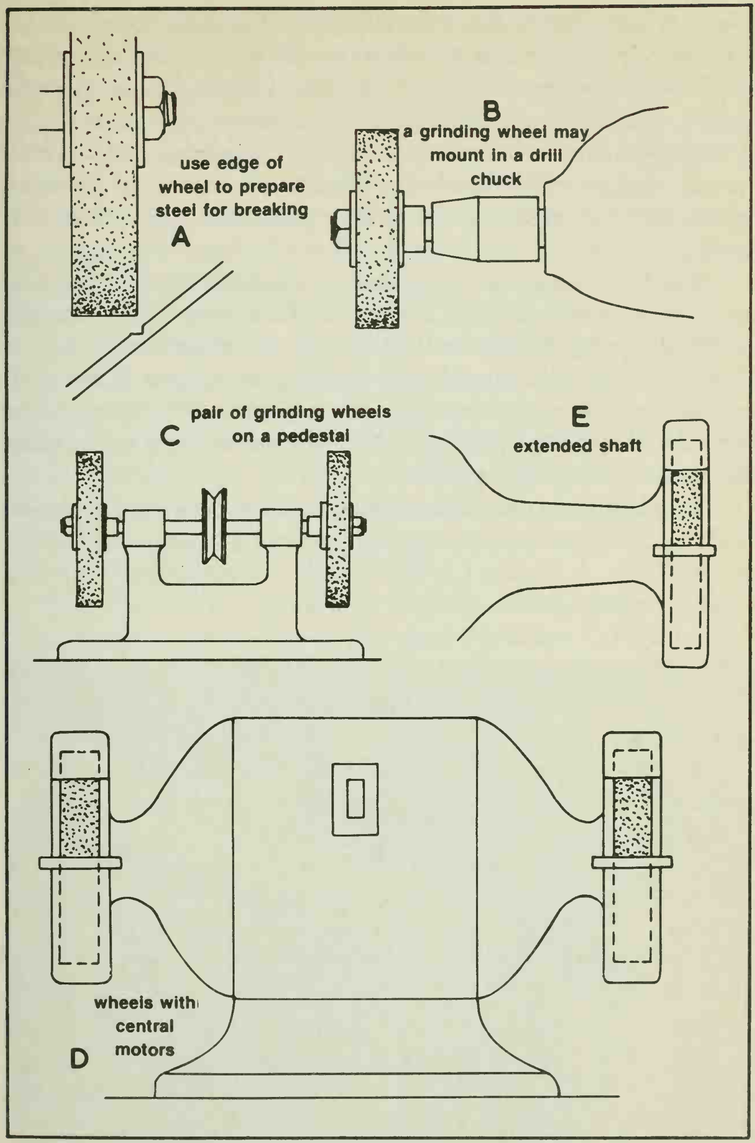


Fig. 4-2. A grinding wheel mounts on a screwed spindle, or a small one can be on an arbor mounted in a drill chuck.

over the steel may be more convenient for cutting off, but for most of the work that has to be done on a knife blade, the fixed double-ended grinder is a better choice.

In a normal use, a grinding wheel keeps its shape for a long time and can continue to do accurate work as long as it remains cylindrical. A stone that is used at less than its design speed will wear away rapidly and may go out of true in the process. Misuse of a stone may wear grooves in it or round an edge excessively. It is possible to *dress* stones true again. A dressing tool will also remove dirt and other materials embedded among the grit. A stone intended for steel should not be used for soft metals, which will clog it.

One type of stone dressing tool has a number of starred wheels rotating loosely on an axle at the end of a handle. When brought to the revolving stone over the tool rest, the wheels rotate with a jumping action to break off high spots of a worn stone. It is moved across the stone until the surface is true. There will be flying sparks and particles of stone. Goggles should be worn, and it is advisable to mask the nose and mouth.

Another dresser has a diamond mounted in the end of a handled rod. This kind of dresser is graded according to the size of wheel it will dress. A diamond dresser is used in a similar way to the starred wheel type.

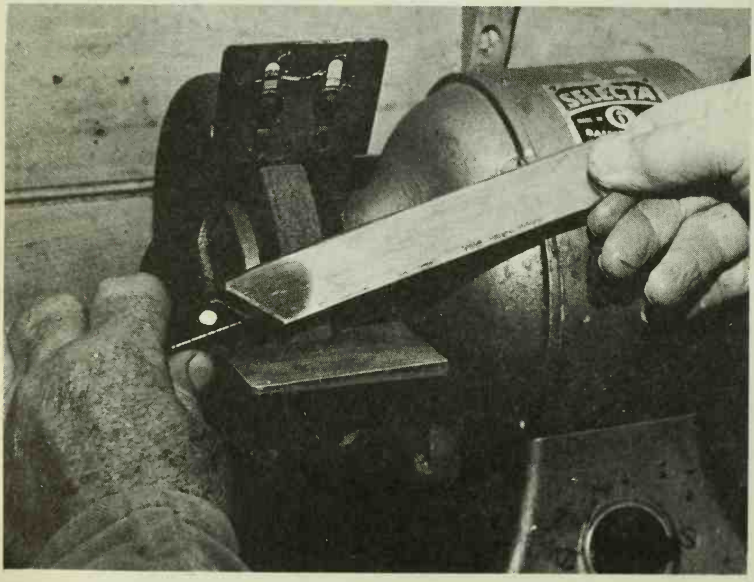


Fig. 4-3. The usual small grinder has the wheel on the motor shaft and is shrouded for safety. A protective shroud around a wheel restricts flying particles of grit and provides a mount for a tool rest. So far as possible, hold a tool with both hands and let the tool rest take the thrust from the wheel turning toward you.

In industry, hard steel is cut with an abrasive cut-off wheel. These thin grinding wheels are usually large, but if one can be obtained of a size to fit in place of the circular saw in a table saw bench, it can be used to make straight cuts across steel of any hardness. It would be particularly useful in bringing salvaged hardened and tempered steel to workable sizes.

Another way of cutting steel is with a flame. This has to be an oxyacetylene torch. A propane torch does not generate enough heat for cutting. Of course, there have to be clyinders of oxygen and acetylene as well as the lengths of piping to the torch, so this equipment may be more than would be installed in an amateur's shop, but it may be possible to borrow the equipment or get the use of it at a college occasionally. The torch should have welding and cutting tips, or there can be interchangeable torches. The edge left after burning through steel is rather rough, so there has to be much more grinding to shape to remove all this unevenness, which affects the surfaces as well as the edges, but cutting with a torch is quicker than with other methods.

The torch can also be used for welding, and many things about the shop can be made with welded steel. Most knives do not need any welding, but the torch can be used for brazing and silver soldering, although those jobs can be done with a propane torch just as well. An oxyacetylene torch will burn holes through tangs, but they will not be round, and there will have to be some grinding to true the surfaces around them.

SHAPING

Sawn or flame-cut edges will usually be far from true and will have been deliberately cut outside the intended line to allow for working to shape with more accuracy.

If carbon steel is to be brought to shape by hand methods, it has to be filed. As with sawing, there should be several teeth in action at the same time. This means that fine files are better than coarse ones. To get as many teeth cutting as possible and to reduce vibration, have the steel projecting only a small amount from the vise and use the file with one hand on each end, working at a fairly acute angle to the edge of the steel. Take the file across using most of its length, so that it makes a diagonal cut from the tip to the heel in the length of the steel edge (Fig. 4-4A). Use enough pressure to keep the file cutting.

Most work can be done with a file about 10 inches long. Flat and half-round sections will deal with most knife shapes. If a file

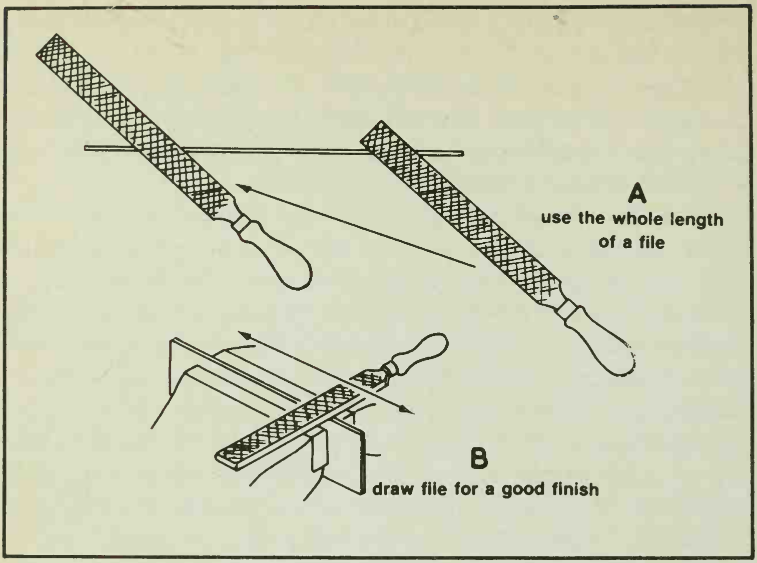


Fig. 4-4. Filing should be done along as well as across an edge, while draw filing at right angles smooths the surface.

is held across and moved sideways to *draw file* the edge (Fig. 4-4B) it will smooth out the cross file marks. Particles of steel tend to clog the file. This can be reduced by rubbing the file with talc, so chalk dust fills the spaces between teeth. Any particles of steel that become lodged can be cleaned out with a wire brush pulled across.

Filing away much steel can be tedious, and files used on steel do not have a very long life. It is usually more satisfactory to grind it. This may be with a grinding wheel, but there are other ways of using hard abrasive to wear away steel. Although there are natural stones that can be used, most modern grinding methods use grits that may be from natural sources or are synthetic. They are graded in size. Coarse grit can be used for the quick removal of metal. Grades may not cut as rapidly, but they produce a smoother finish. Grits are graded by number—the smaller the number, the coarser the grit.

Grinding wheels mount on shafts, called *arbors*. Bearings are roller or ball. A large shaft diameter should have a longer life than a small diameter one before wear causes the wheels to vibrate, but there is not usually much choice, unless you are buying large industrial grinders. Nuts hold the wheels on their arbors between large discs or washers. All but the working part of such a wheel should be surrounded with a cover or shroud. This restricts the grit that flies about and protects the worker if a piece of the wheel should fly off.

Another way to use grinding grit is to fix it to a paper or cloth backing. With modern adhesives it is possible to do this securely so that the grinding paper has a long life. The process is often called *sanding*, but the use of sand disappeared to a long time ago, and only the name lives on.

There are several ways to use these abrasive sheets. A simple arrangement is a disc sander. A round slightly flexible rubber pad is mounted on an arbor to fit in the chuck of an electric drill (Fig. 4-5A). This can be used to grind steel, but the abrasive sheet is only held at the center, and it may tear away before it has worn out. Another type of disc sander has a rigid backing with the abrasive sheet stuck to it (Fig. 4-5B). The adhesive allows peeling the sheet off, but it holds firm enough to prevent whatever is being ground from tearing it away. This works well on straight edges and convex curves, but it will not get far into concave curves.

Another type of grinder has a foam plastic or rubber cylinder or drum on a shaft, which is driven by a motor or mounts in an electric drill. A continuous abrasive band fits around the foam and is held by adhesive. Centrifugal force throws the foam and belt out fairly rigidly so that anything held against the outside of the drum can be grounded. There is some flexibility, and the band will conform to shapes (Fig. 4-5C). For anyone making only a few knives, this is a simple and inexpensive type of grinder for shaping steel.

It is possible to get abrasive strip in long roll, and this is much cheaper than prepared bands. Strip abrasive is worth having for hand work, but it is possible to have a drum sander to use this strip. Instead of the cylinder in one piece, there is one made in two parts. It can be opened and the strip wrapped around with its ends locked between the parts (Fig. 4-5D). The clamping discs have to be really tight, and the band must be tightly wrapped around, or the joint will cause a ridge that quickly wears through.

A more useful type of belt grinder has the abrasive band around two cylinders (Fig. 4-5E). A pad under a flat part takes the pressure of the work being ground, but the knife can be moved to a space for a more flexible grinding or to a cylinder for getting into hollows. Such belt sanders may be fixed machines where the work is manipulated on them, or they may be portable and mainly intended for wood, when they are handled like a plane. Both types have their uses in knifemaking.

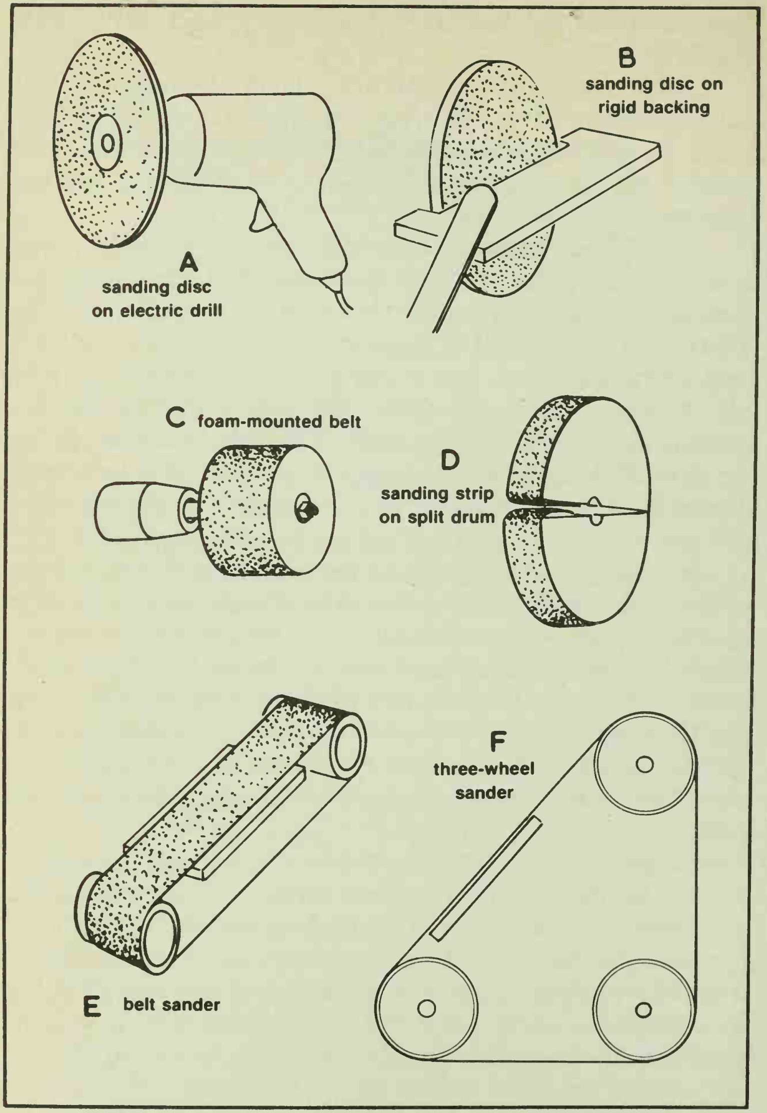


Fig. 4-5. Sanding discs are useful for shaping and finishing. A drum sander works like a grinding wheel. Belt sanders have flat working surfaces.

An even better belt grinder is less common, but it has three wheels (Fig. 4-5F). This takes a longer belt, which will have a longer life, and it gives greater choice of the way things are ground. In both types of grinder, it is common for the wheels on which the belt runs to be supported by studs at one side only. This gives maximum clearance for manipulating the work at the other side. It also allows for adjustment of tracking. If all the wheels are exactly in line and the belt has been made perfectly, the machine will run without the belt trying to work its way sideways. Perfection is unlikely, so correction is made by a fine adjustment of the angle of at least one of the wheels.

Although the cylindrical wheels are iron, the belt is given a grip and is driven by coating the wheels with rubber. This gives some flexibility as well as drive, when the work is held against a wheel for grinding. Although much grinding is done with the belt tracking centrally, the adjustment can be altered, while the machine is running, so that the belt extends to one side, giving a flexible edge for getting into hollows. A narrow belt (about 2 inches) is better for knives than the wider type often fitted.

A recently introduced sander with a difference is the flap sander. It is of no use for shaping but is a finishing tool for wood and the softer handle materials. Strips of abrasive project outward like bristles on a central cylinder. They hit the work rapidly and give a good smoothing effect.

DRILLING

The possibility of burning holes through a knife tang has been mentioned, and that method may sometimes have to be used, but a better hole results from using a drill. The actual cutting tool may be an ordinary steel twist drill, preferably of the type often described as *high-speed steel*, or an even harder special alloy tip. It is possible to settle for one size of rivet hole in most knives, so buying a rather expensive drill with a hard tip may be a good investment. It is difficult to resharpen drills as accurately as they come from the makers, and slightly incorrect angles may cause a drill to rub instead of cut, so it blunts and the steel work-hardens. A special drill that holds its edge for a long time will reduce this trouble.

Freehand drilling with an electric drill held in the hand is not advised for steel. A drill press gives good control, but a stand for a hand electric drill will achieve the same results, while still allowing the hand drill to be used elsewhere when required.

It is important to apply enough pressure to keep the drill cutting. This generates heat. To prevent it from affecting the steel, there should be a lubricant applied. The simplest effective lubricant is soapy water applied occasionally with a small brush. There are much more sophisticated lubricants and ways of applying them, but for the small number of holes to be drilled at a time in knives, soap and a brush are adequate.

Drill at the machine's slowest speed. A high speed may be an advantage for wood or soft metals, but for steel the cut is much better at a low speed. Support the knife on a flat piece of hardwood so that the drill breaks through into it. Make sure the drill chuck is as tight as you can get it. The greatest strain comes as the drill breaks through the far side. If it seizes then, it may lock the drill so that it slips in the chuck and may break. The knife should be held with pliers or a hand vise. A seizing drill may pull the work out of your hand or break itself.

If a piece of hardened and tempered salvaged steel has been ground to shape, holes cannot be drilled in the normal way without annealing the steel. This involves a delay of several hours for slow cooling, then hardening and tempering has to follow drilling. It may be possible to avoid this time and extra work by trying one of two methods.

It is possible to use a drill press to anneal the steel in the immediate area of the hole only. A piece of steel rod with a flat end and of a diameter slightly larger than the intended hole is mounted in the drill chuck and brought down on the spot where the hole is to be. Pressure is put on and the friction will generate heat. Colored oxides will appear. Continue until blue has been reached and hold this pressure a little longer. Allow the steel to cool slowly. The part that became blue should be soft enough for drilling. Do this work while the knife is resting on a wood pad and leave it there (Fig. 4-6A). Resting on steel would cause the heat to be carried away quicker, and this is not what is wanted.

Use a high speed to generate maximum heat-producing friction, but when changing to a drill to make the hole, change to a slow speed and keep the drill cooled with a lubricant (Fig. 4-6B).

With much thin steel it is possible to punch holes, even when the steel is hardened and tempered. The hold may not be cleanly rounded, but that will not matter when the tang is to go between slabs and be prevented from sliding with epoxy glue. Lighter knives, made from large springs, bandsaw blades, and other carbon steel less than $\frac{1}{16}$ inch thick may be punched, thereby avoiding the need to anneal, drill, and reheat-treat.

The punch should have a flat round end about the same size as the rivet or pin. In the method used by some knifemakers using only primitive equipment, the steel is placed over a nut resting on an iron block and the punch is hit over the nut hole (Fig. 4-6C).

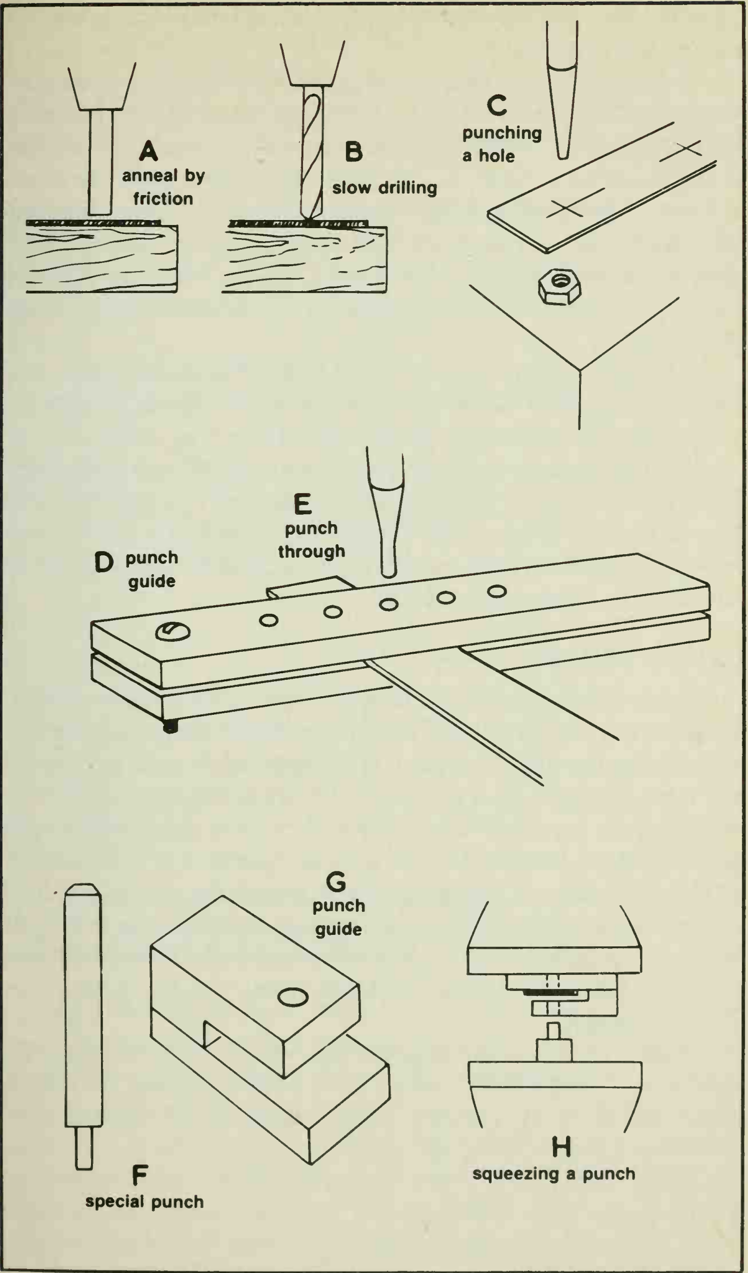


Fig. 4-6. One way of locally annealing steel is to rotate a flat-ended rod so that friction generates enough heat to draw temper. It is also possible to punch holes with or without a guide.

This involves carefully lining up the nut, the hole position, and the punch, but it works.

A better arrangement uses a guide. One simple type has two steel strips loosely linked with a bolt at one end and matching holes in the pieces (Fig. 4-6D). The marked position for a hole is sighted through one piece. Then the ends are held together while the punch is driven through (Fig. 4-6E). There can be holes in the guide and punches to suit various sizes. Extra positions for commonly used sizes will allow a change if holes wear, but the whole thing can be turned over and used the other way to give a second set of sharp-edge holes.

The punch does not have to be tapered to a long point. It is better to have a parallel end just long enough to break through the steel, with the rest of the punch left thicker (Fig. 4-6F).

Another guide is made with a lower tempered carbon steel part and a guide above it, which could be mild steel, and held to it with screws or rivets (Fig. 4-6G). The punch is best made with a parallel end. It could be long enough to hit, or a short punch might be squeezed in a vise (Fig. 4-6H).

OTHER TOOLS

Various arrangements for holding cold and hot steel are needed. The first is a vise. This may be any parallel-action engineer's vise mounted on the bench so that it stands up and you can get around any work gripped in it. A jaw width of 3 inches will suit most knives. The jaws are hard steel and made with teeth to grip anything put between them. Much of the work we do is smooth or polished and teeth marks are not wanted, so some covers for the jaws should be made (Fig. 4-7A). They can be copper, aluminum, or other soft metal and $\frac{1}{16}$ inch thick to absorb the penetration of the jaw teeth. Regard them as disposable and be prepared to make others from scrap materials.

If there is no separate woodworking vise the metalworking vise should be provided with wooden jaw covers. Gripping wood with metal will mark it. The jaw covers should be of close-grained hardwood fixed to metal backings and arranged to stand a little outside the metal, to protect woodworking tools from damage (Fig. 4-7B). Some vises are equipped with fiber-faced jaw covers, intended for holding polished soft metals, but for holding wood it is better to use wooden jaw faces.

Pliers of various sizes and sorts are useful, but it is also useful to have some grips of the type that will lock on to thin metal. When

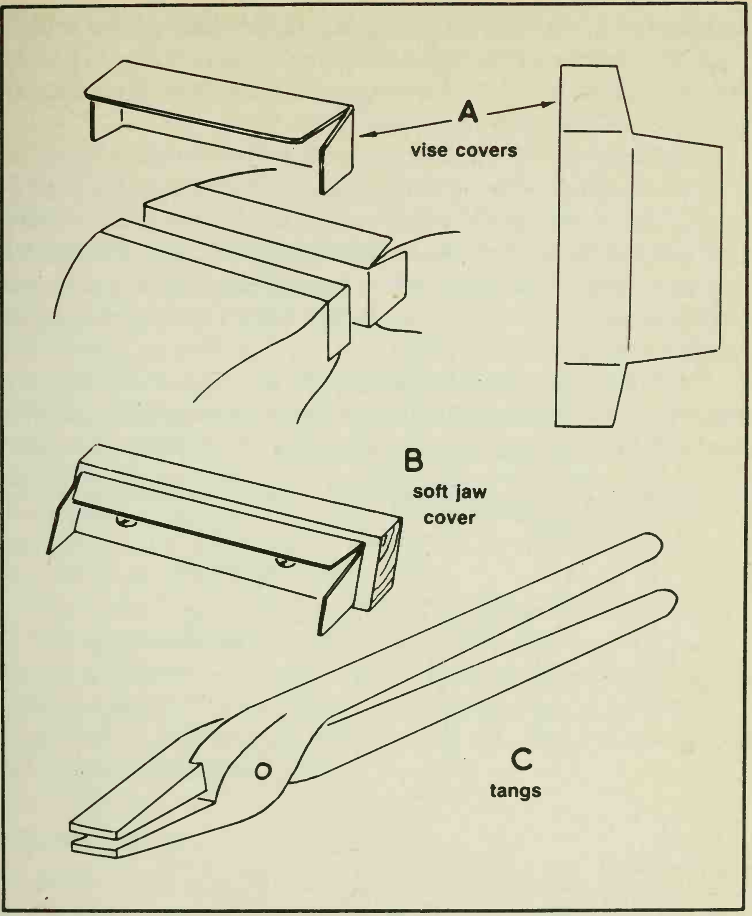


Fig. 4-7. Sheet metal vise covers prevent jaws from marking polished work. Long tongs are needed to hold hot steel.

handling hot metal their positive grip makes the risk of the hot metal's swinging and touching the hand less probable. Pliers and grips are not long enough to keep the hand away from the heat in some treatments. The tool to use then is a pair of blacksmith's tongs (Fig. 4-7C). Tongs are made with many kinds of jaws. There are *open-mouth* and *closed-mouth* tongs. The open mouth ones do not close completely and are intended for holding thick work. It is the closed mouth type that are needed for holding hot knife blades. Exact size is not important, but an overall length of 18 inches is about right. Secure grips are important when holding a knife blade for drilling. One of the other holding devices may do, but an engineer's hand vise gives you a firm safe handle on the work.

Glued handle assemblies can often be held together in a vise, but it is helpful to have a few C-clamps. Using a vise as a clamp prevents its being used for other things.

The best tool for accurately marking steel is a scriber, which is just a steel point for scratching. This is something that can be made. Tempering should only be slight so that the point is quite hard and will make a positive scratched line that can be seen easily. The point may break occasionally, but is easily reground, and this trouble is worth the better line. With a softer, but stronger point the line would not be as good.

Several general metalworking tools are needed. Almost any hammer will do, but for flattening warped blades one with a slightly domed face is better than a flat one (Fig. 4-8A). If the other side

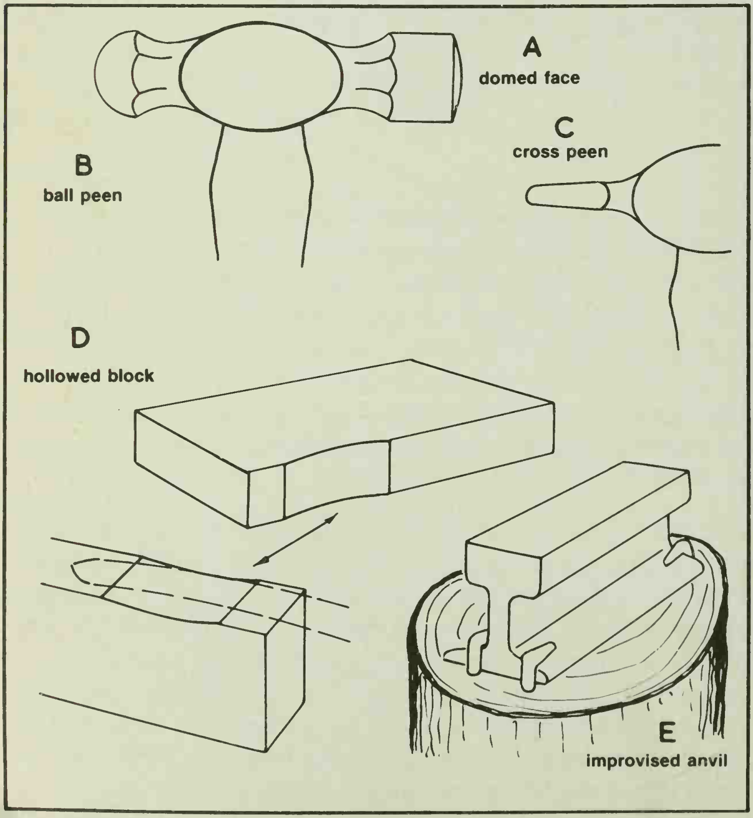


Fig. 4-8. Hammers with shaped peens are needed. Hammering is best done on an iron block or an improvised anvil.

of the head is a *ball peen* (Fig. 4-8B), this can be used for riveting, although in some circumstances a *cross peen* is better (Fig. 4-8C). For most work any hammer that is comfortable to lift is a suitable size.

There should be an anvil of some sort, but there is no need for a proper smith's anvil, although that would be useful if available. A block of iron or steel will do. It should be heavy enough not to bounce on the bench when hit and have a sufficient area of flat top to support a knife blade being hit. A typical suitable piece of iron would be 6 by 3 by 1 inch, but anything bulky and heavy will do. A flat top is all you need for most things, but one edge straight and square is occasionally useful. A slightly hollow or concave surface can be used for flattening—a curved blade hit on a flat surface may not finish absolutely flat, because it springs back a little under a blow. Hit it over a slight hollow, however, and it goes too far and springs back flat. This hollow could be ground in the side of an iron block, so it could be stood on edge and used that way, when required (Fig. 4-8D).

Something nearer the shape of a smith's anvil would be a section of railroad track. This gives a working surface at a more convenient height than a flat iron block. Its flanged flat bottom could be held down with spikes bent over it. A section of three trunk makes a good base for any type of anvil. The log absorbs shock and reduces noise (Fig. 4-8E).

POLISHING

Steel and other metals have to be brought to a polished finish for the best appearance. Wood should also be polished, but there is a difference in the treatment. Polish on metal is achieved by working it with successively finer abrasives until the scratches from the last one are too small to be seen, and that is what we call a polish. Wood can also be treated with abrasives in this way. Although the surface achieved will be smooth, it will not have the sheen of a polish. The polish on wood is obtained by applying wax, oil, or varnish, which is then given a sheen.

Rubbing down steel to polish is very slow and laborious if done by hand. The ground steel can have the grinding scratches removed by a disc, drum, or belt sander or grinder. Several grades of grit can be used. It is important that each grade is cleared, by wiping off dust, and that the next grade each time thoroughly removes the marks of the previous grade. Letting the abrasive cut at a different angle to the previous grit will help in showing when the earlier marks are removed.

By working down to a very fine grit it is possible to get what may seem an acceptable surface finish, but for the highest polish it is necessary to change to buffing. This is done on a revolving wheel. The wheel is mounted on a spindle driven by an electric motor (Figs. 4-9 and 4-10). A common assembly looks like a double grinder, with the buffing wheels in place of the grinding wheels. It is possible to have a motor with a grinding wheel at one end and a buffing wheel at the other.

There are many sorts of buffing wheels, made of rubber, felt, and metal bristles, but the most common are wheels made up of a great number of cloth discs. In some cases, the discs are only held in the central area. Centrifugal force then throws their circumference out to quite a hard surface to press against. Other wheels have stitches around, and these are best for hard materials, like steel (Fig. 4-11A). The buffing wheel may be clamped with a nut on a spindle, or the spindle may be a given tapered thread on to which the wheel is screwed. This thread has to be arranged so the wheel tightens under load, so the thread at the left side of

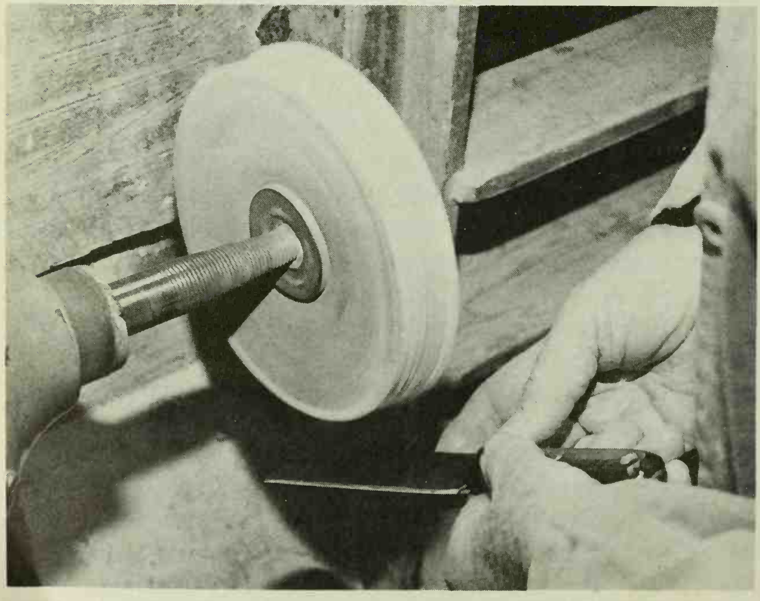


Fig. 4-9. A cloth buffing wheel usually screws onto a spindle. It revolves so that the top is turning toward you. Bring the work up to the bottom of the wheel and hold to resist the pull caused by friction.

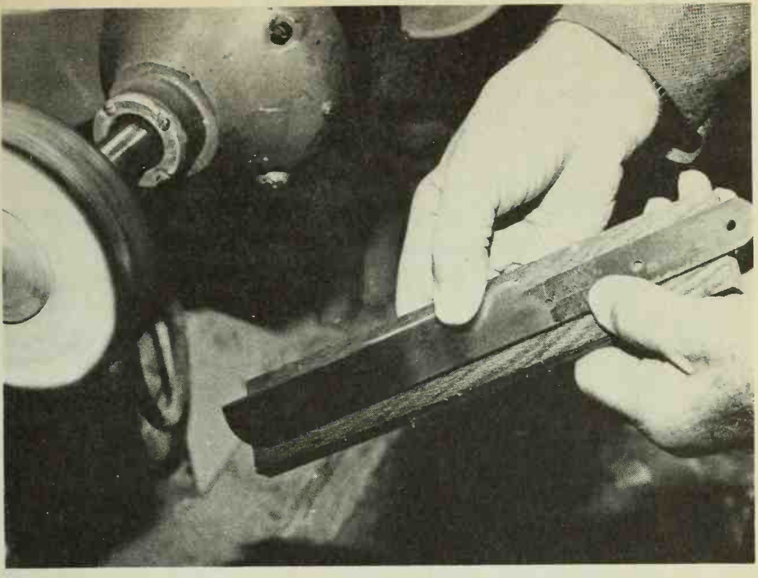


Fig. 4-10. Thin metal being buffed can be held against a piece of wood to stiffen it under pressure.

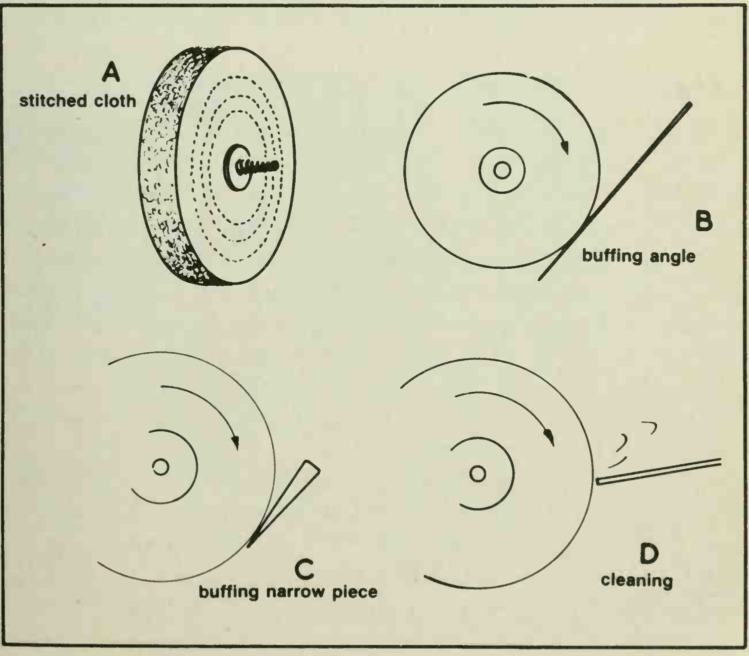


Fig. 4-11. Grind and buff with the metal held in the direction of rotation, except when scraping a cloth buffing wheel.

the motor has to be left handed.

Buffing is done with compounds that come as sticks with the fine abrasives in a hard wax. This is held against the wheel to change it. There are many buffing compounds, and it may be necessary to use a coarse one followed by a fine one to get a satisfactory finish. They cannot be used on the same wheel. Wheels can be changed, but a double-ended assembly allows two wheels to be kept set up. More about buffing will be given later with instructions for making knives, but an important safety consideration is the need to always hold anything against the wheel so the pull is downward (Fig. 4-11B). When buffing anything narrow, keep contact with the lower half only (Fig. 4-11C) so that the top edge cannot catch in the wheel and kick.

The surface of the wheel will become clogged with a dirty mixture of polish and tiny particles of steel. This has to be cleaned out occasionally. Hold an old knife or a straight-edged piece of steel against the revolving buffing wheel. Point it toward the spindle. Hold tight to resist the kick, and use the metal edge to scrape the wheel (Fig. 4-11D). This will remove some of the cloth. Eventually the wheel will have to be renewed, but wheel life should be quite long.

SAFETY EQUIPMENT

Precautions to take are mentioned in connection with processes where they are necessary, but in the approach to knifemaking it is important to always be aware of the need for safety. Some of the work could be dangerous if tackled casually without being aware of the consequences or without using suitable safety equipment.

Your normal dress should not include anything hanging. A loose necktie catching in a revolving spindle could be very hazardous. It is better not to wear one. A loose coat could be almost as dangerous. If possible, use a leather apron that reaches over your chest and down at least to your knees. Alternatively, let it be stout canvas.

Protect your hands when grinding small pieces by holding with a hand vise (Fig. 4-12). You may want to do some work with your bare hands. When working at the vise or otherwise doing a static job, this is quite satisfactory, but when you deal with a grinder or buffing wheel, the metal may get hot, and it may catch and kick in a way that could hurt you. Heavy industrial gloves should be worn then. A knife may not be brought to a cutting edge until the final process, but a kicking piece of sheet steel with an apparently

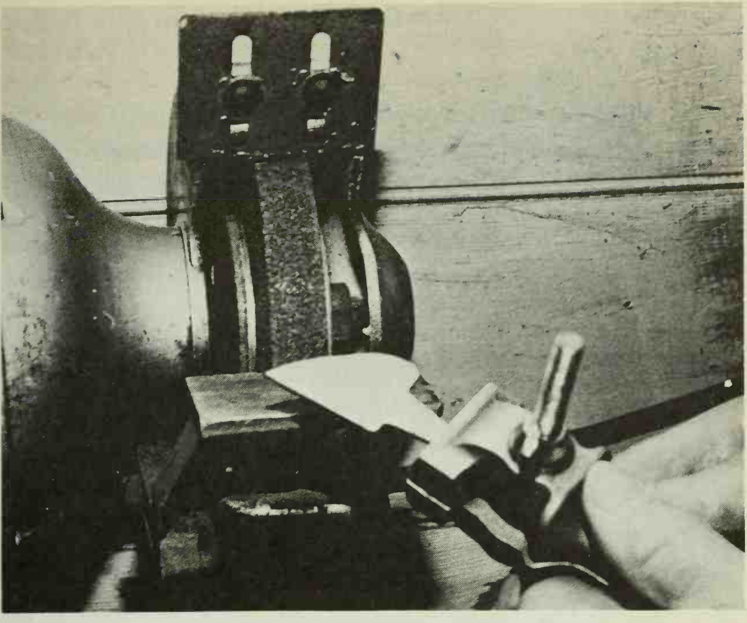


Fig. 4-12. Small parts can be held with a hand vise for security, to keep hands away from the wheel, and to allow you to see better how work is progressing.

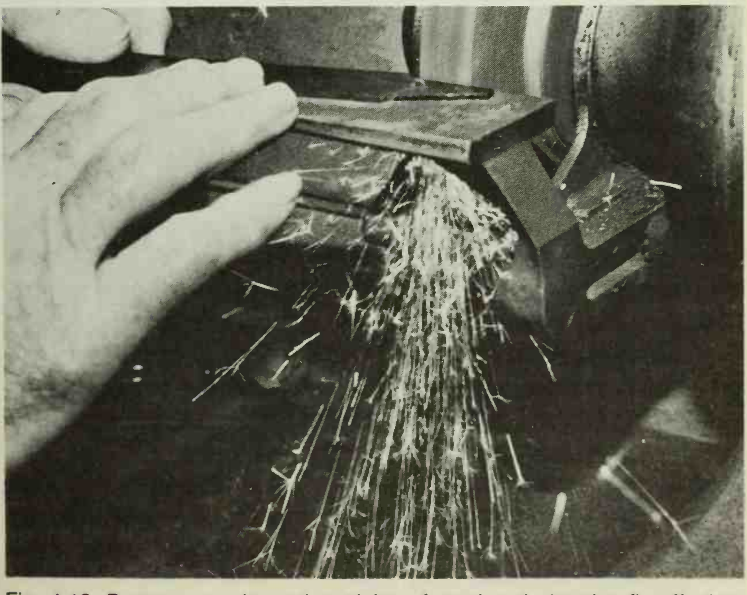


Fig. 4-13. Because sparks and particles of steel and abrasive fly off when grinding, you should, at least, protect your eyes, nose, and mouth.

blunt edge can still draw blood.

There is a risk to your eyes and lungs from sparks and flying particles of grit and steel dust when grinding (Fig. 4-13). There may not be anything hard thrown off when buffing, but there is a considerable amount of dirty abrasive dust that could be hazardous to your lungs if breathed in any quantity. Some grinders have transparent screens to lower and look through. Keep the screen clean and position your head so that your lower face, as well as your eyes, is protected by it. Otherwise, you should wear goggles when grinding, preferably the type with side protection, or you could wear a visor that will swing up when not needed (Fig. 4-14).

If you are only grinding or buffing briefly, you may not feel the need for protection for your lungs via nose and mouth, but for more prolonged work, you should wear some sort of filter. It does

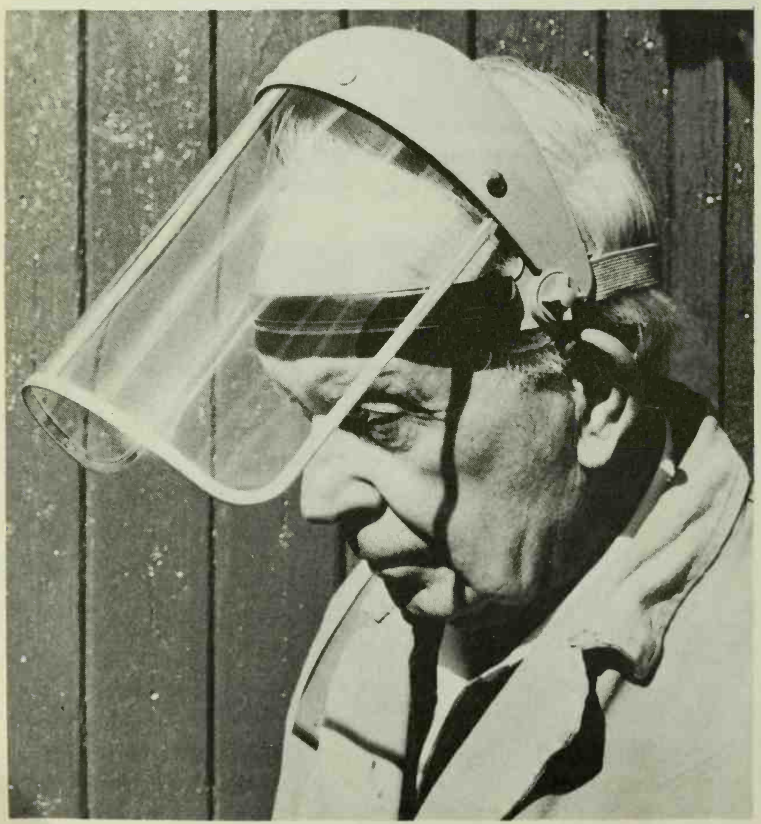


Fig. 4-14. A visor, which can be swung out of the way, will protect your face when grinding or buffing.

not have to be anything as elaborate as the masks used for paint spraying or work with other toxic substances. You may just tie a handkerchief bandit-fashion over your nose and mouth, but a simple mask that has a metal frame to hold a disposable gauze pad is simple and effective (Fig. 4-15).

The appropriate screen or goggles are obviously needed when you are welding or even watching someone else welding or flame-cutting.

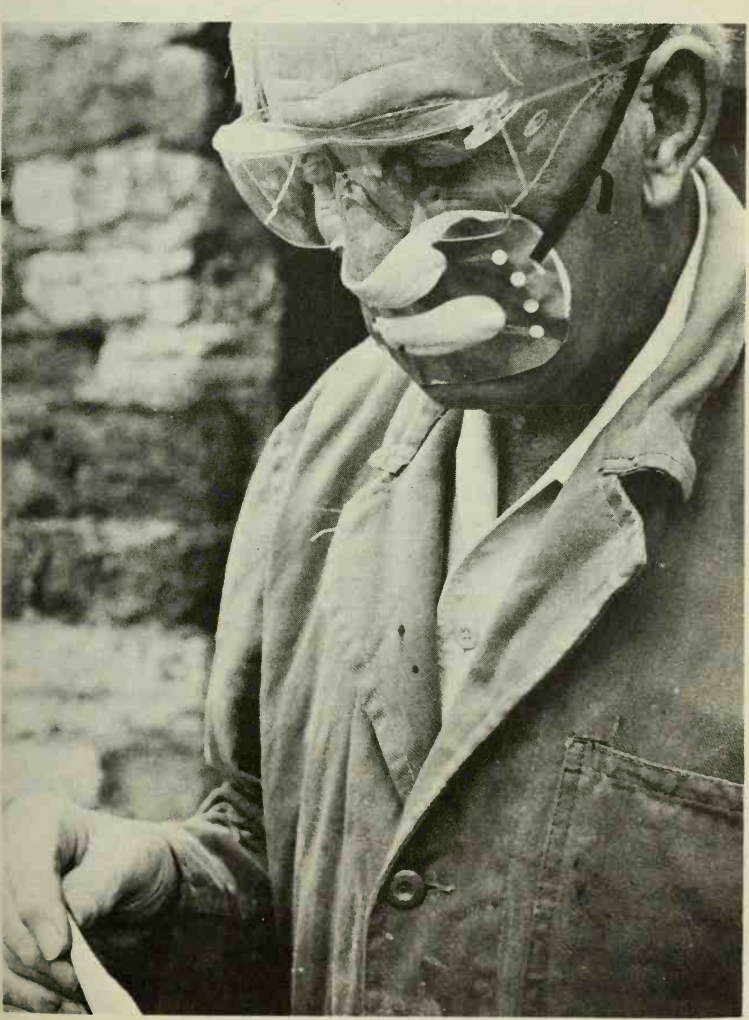


Fig. 4-15. Goggles, with top and side pieces, will protect your eyes, and a mask will prevent dust from entering your nose and mouth.

WOODWORKING TOOLS

The wood used for making handles is not too large, so it is possible to do the work with the minimum of tools. Some of these can be the same as those used for metalwork. The various types of sanders can be used on wood using belts or discs. Abrasive used on steel is label to become clogged with metal particles that would affect the quality of the surface obtained on wood. Besides scratches, there could be particles left embedded in the grain.

The most useful woodworking power tool is a bandsaw. It can cut wood for slabs with a broad blade, although a circular saw could make these straight cuts, if available. A narrow bandsaw blade will follow the curves of handle slabs and leave very little finishing to shape. Without a bandsaw, it is not very hard to cut slab material to shape with handsaws. A power jig or saber saw will follow outlines. The hand tool is a coping saw.

There is no need for a jointer or planing machine, although if it is already there it can be used. Wood for handle slabs may be planed with a smoothing plane, such as a Stanley #4. A low-angled, one-hand block plane may have occasional uses, but there should be no other plane needed. Some shaping will be done with a belt or other sander, but Surform tools are useful for general shaping with a filing action. With flat and curved blades it is possible to follow almost any shape. It is better to get the wood close to the finished shape in this way, so the abrasive only has to reduce the surface fairly evenly all over. If abrasive has to reduce a very uneven surface, it is possible for the sanding of high spots to take too much off adjoining low parts inadvertently.

Drilling of rivet holes can be done with the same bits and electric drills as used for metal. Only if holes bigger than about $\frac{1}{4}$ inch are needed is it better to use a woodboring bit to get a clean hole. There may have to be counterboring to suit some rivets, but the appropriate bit is described with the process. For a straightforward countersink, use a normal countersink bit. The slow turning of a hand bit brace will produce a better countersink than a bit in an electric drill.

A few wood chisels may have occasional uses. Such things as try squares and marking gauges will find uses, if you have them, but otherwise these small pieces of wood can just be marked with a pencil and rule.

SHARPENING

When you grind what is to be a cutting edge the actual line where both sides of the tool meet will be fairly serrated with a pattern that matches the size of the grit in the grinding wheel. You can probably see this with the naked eye, but a lens will show it like a fine saw. For an ax or similar tool, that may be all that is needed, but for most cutting tools you have to work the edge down with progressively finer abrasives. How far you go depends on the use of the tool—a razor would obviously have to be finished to a finer edge than a chisel.

The process that follows grinding is known as sharpening, honing, or whetting. The work is done with stones on which the tool is usually rubbed, although for some edges it is better to use the stone on them like a file. There are natural abrasive stones; two well-known ones are *Washita* and *Arkansas*. Other stones are manufactured; examples are *India* and *Carborundum*. Manufactured stones are usually coarser than the natural ones. There are double-sided coarse and fine manufactured stones, and these may be all you need for general sharpening, but for finer edges you can follow with a natural stone. Standard stones are about 8 by 2 by 1 inch thick, to suit chisels and plane irons. For knives only, you can manage with a smaller one.

A stone should be lubricated with thin lubricating oil, kerosene, or special sharpening oils. Do not use thick engine oil because it keeps the tool edge from the stone. It is possible to lubricate with water, but as oil and water do not mix, you should settle for one

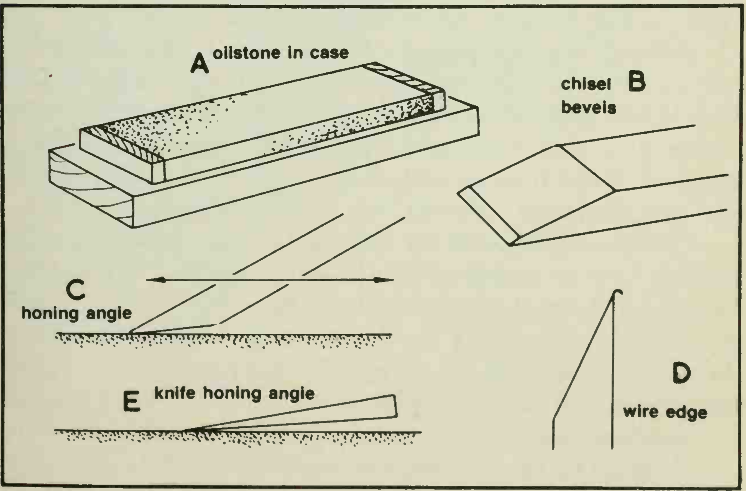


Fig. 4-16. Sharpening or honing is done on an oilstone. A chisel has a second honing angle. A turned-over wire edge indicates sufficient honing.

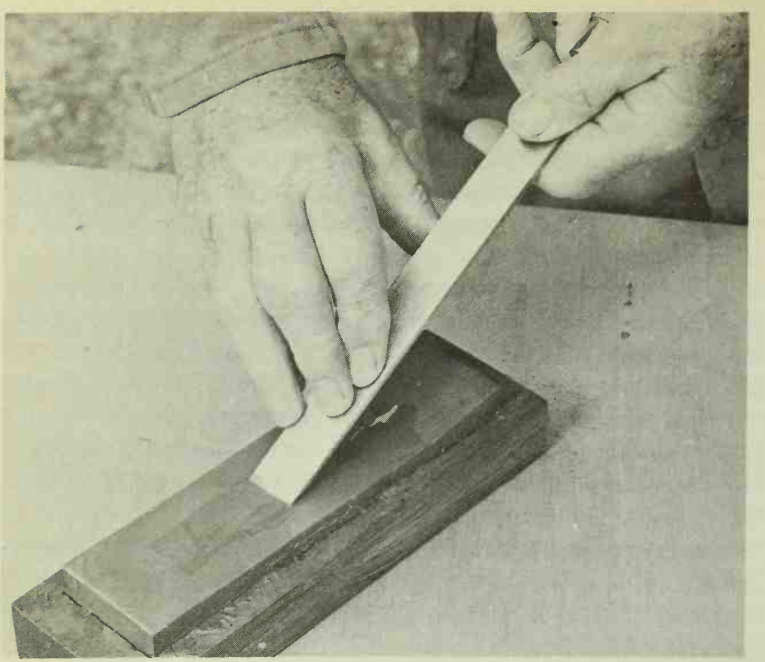


Fig. 4-17. Control the angle of a chisel with one hand while pressing with the other.

or the other. For shop use, oil is better, but for a stone to be used away from home you could use water. Without a lubricant a stone wears rapidly and does not produce as good an edge.

Have the stone mounted in a box or block of wood, preferably with a cover and the minimum width of wood projecting at the sides (Fig. 4-16A). Some stones are mounted with wood level with the surface at the ends in case a tool runs over. Try to keep the surface of a stone flat by rubbing tools all over it. Do not fix a stone in its box—you may want to turn it over or use the side.

Chisels and plane irons are examples that show the sharpening process. They are usually given a long grinding bevel at about 25° and shorter sharpening or honing angles at a slightly higher angle (Fig. 4-16B). When this bevel gets long, because of several sharpenings, the tool is ground again. When sharpening, have the oilstone box in a vise or held firmly on the bench. Keep the tool at a consistent angle as it goes along the whole length of the stone (Fig. 4-16C). One hand on the chisel handle or top of the plane iron controls the angle, while the fingers of your other hand just behind the cutting edge control pressure (Fig 4-17).

Wipe the oil away and feel the other side of the blade. If you have achieved sharpness, you will feel a roughness, which is the tiny particle of steel forming a wire edge, which is still clinging to the sharp edge (Fig. 4-16D). Rub that side of the tool with a circular action flat on the stone (Fig. 4-18). This may remove the wire edge, but to be sure, slice the edge across a piece of scrap wood.

If you want to make an even finer edge, make sure the tool is clean, then sharpen and remove the new wire edge on a finer stone. This time you may not have to sharpen very long, as all you are doing is removing the scratches made by the grit of the first stone and replacing them with the finer scratches of the second stone.

Honing a knife edge is done similarly, but both sides should have equal bevels. The angle to hold the knife is best found by a trial and will be at an angle slightly lifted from the stone (Fig. 4-16E). An edge that will be used only on soft material can be flatter and, therefore, finer than one intended for heavy and rough use,

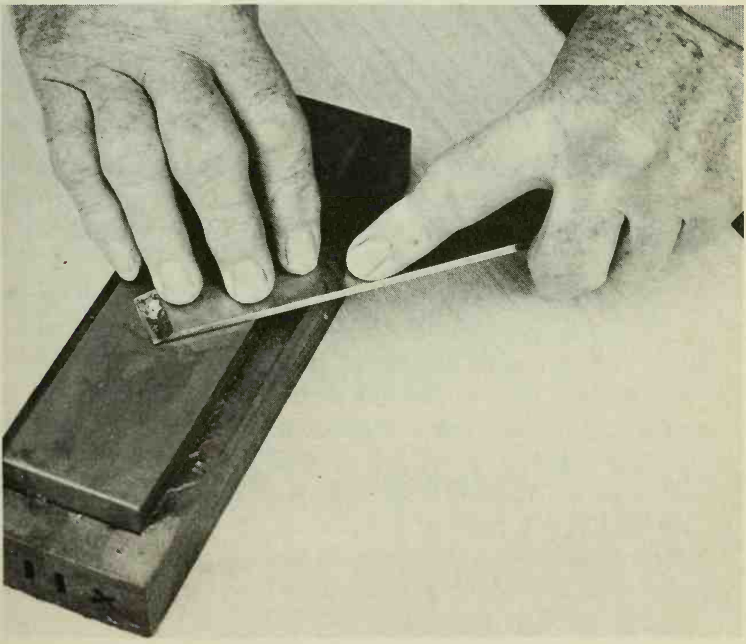


Fig. 4-18. Remove the wire edge by rubbing the flat side of the chisel on the stone.

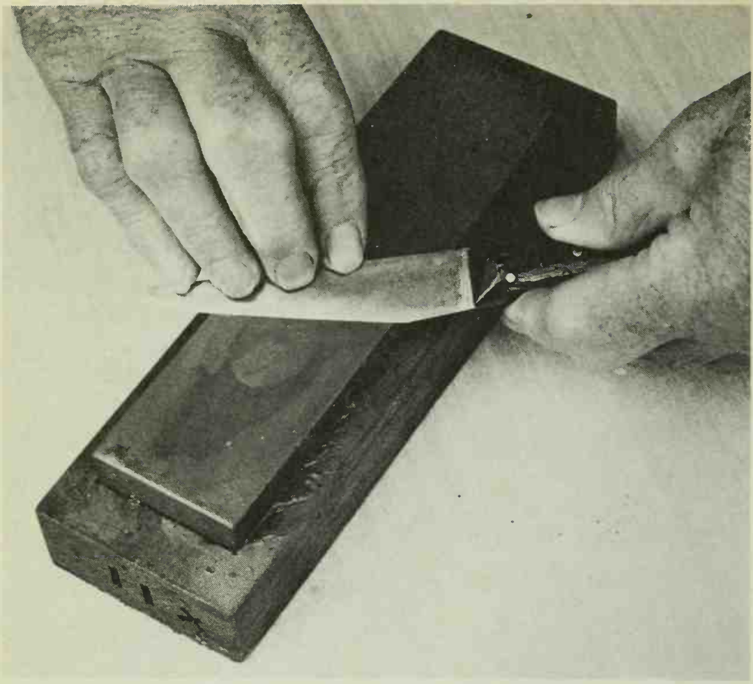


Fig. 4-19. Maintain the angle of a knife blade with a hand on the handle, and apply pressure with the fingers of the other hand.

where too fine an edge would quickly blunt. Let one hand on the handle provide control, while the other hand puts on pressure (Fig. 4-19). Move about on the whole surface of the stone and try to maintain the same angle throughout.

Rub opposite sides the same amount and at the same angles. Do not turn over between rubs, but give about twenty rubs on one side and then the same number on the other. If the knife edge is curved, you will have to vary the attitude to the stone, but try to keep the same cutting angle. Wipe off oil and feel for a wire edge on the side opposite to that last rubbed. If you cannot feel it for the whole length, do more work on the gaps. Remove the wire edge by slicing across a piece of scrap wood.

It is possible to see blunt parts on an edge. If you hold the knife across in front of you with its edge upward and a light source farther in front of you, any blunt parts will reflect the light and appear white, showing you where more sharpening may be needed.

A knife can be given an extremely fine edge by working through increasing finer-grit stones. A final finish may be given on a *strop*, a piece of leather on a wood backing, preferably dressed with an extremely fine abrasive in oil. Draw the knife along a few times on both of its sides. Besides razors, carving tools are often finished in this way, but for general woodworking there is no need to go this far.

LEATHERWORKING TOOLS

Leather for sheaths can be cut to shape with a knife, which can be one you make for the purpose. A small general seaman's or butcher's knife will do, although, for cutting out, a short bladed knife that cuts at the tip is more useful. An old broken table knife could be adapted by giving it a wooden handle (Fig. 4-20A). Edges are beveled on the underside. This could be done with a woodworking chisel. A leatherworker uses a broad thin type of chisel, more like a knife that cuts on the edge (Fig. 4-20B). An edge beveler is similar, but the cutting edge has a hollow curve (Fig. 4-20C), so the leather edge it leaves is rounded instead of flat.

Stitching is done with short needles, which can be bought from a leather supplier. Many seams are sewn with two needles, so you need at least two, but allow for losing and breaking some, as well as having to leave needles on thread on partly finished sheaths while starting something else. It is common to sink the stitches slightly below the surface. This can be done by careful work with the tip of the knife, or a little gougelike tool can be bought (Fig. 4-20D), which may be a single handled tool or one of a set of bits to fit into one handle.

Holes for stitches can be punched with a single slender-pointed punch. It could be the same tool as a scriber. There are other stitch or thong punches with several points. A stitch punch may have round or narrow points (Fig. 4-20E). A thong punch makes wider cuts for using a leather thong over an edge (Fig. 4-20F). These punches have the advantage of keeping spacing even to give a neat appearance.

Solid punches make holes without removing leather. If larger holes are needed there are hollow punches. The small circle of leather cut out goes up the central hole, and additional pieces cause it to be ejected through a hole in the side of the punch. In its simplest form the punch is hit with a hammer on a soft metal pad (Fig. 4-20G). Lead is the best metal for the pad, but a scrap piece of thick aluminum on the anvil or iron block will do.

There are plier-type punches that either have interchangeable punch nibs or a rotating head with several nibs of different sizes

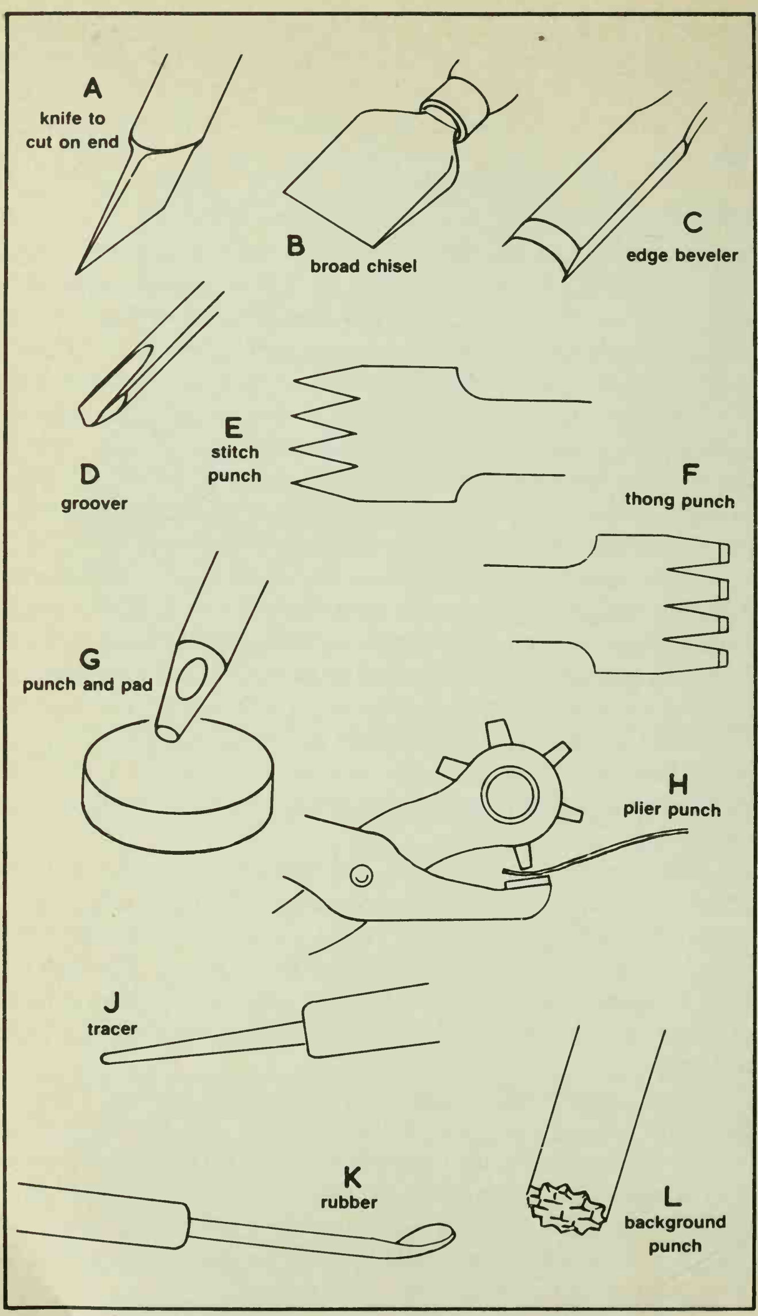


Fig. 4-20. Tools for leatherwork are used to cut, trim, and make holes. Others are used to impress patterns.

mounted on it. They work against a soft metal anvil (Fig. 4-20H). For sheathmaking only the smallest sizes may be needed, so it may be simpler to use single punches with a hammer.

Snaps or press studs are used on straps around handles. Special punches are usually provided in sets by the snap makers. Holes are punched. For the lower part of most makes, the pieces can be joined by spreading the tube of one part in the other with an engineer's center punch. For the upper pair of parts it is better to have the proper tools, where the domed outer part is supported in a shaped metal block and a punch with a special end spreads its projection in the spring inner part.

It is possible to work patterns on the surface of leather. This is done by rubbing with steel tools, all of which can be made by a knifemaker. Rounded tracers in several sizes are needed (Fig. 4-20J). Other shapes are bent and have flattened ends for rubbing down backgrounds (Fig. 4-20K). Both types should be well rounded and polished. Backgrounds may be punched. There are flat-ended punches with various designs, but a suitable tool can be made by filing grooves across the end of a round or square rod to leave points standing (Fig. 4-20L). There is no need to harden and temper any of these decorative tool.

PLASTIC WORKING TOOLS

The many types of sheet plastic have different characteristics. Those that may have uses in handles can usually be worked with similar tools to metal.

Ordinary metalworking twist drills tend to snatch into some plastics. The smallest drills may be satisfactory, but anything over about $\frac{1}{8}$ inch may suddenly grip the plastic and break it. There are special drills with straight or steeper twisted flutes that are intended for plastics, but ordinary drills can be adapted by grinding off each cutting edge so its leading edge is vertical (Fig. 4-21A). It is the far side that may break out, so support it tightly with another piece of plastic or hardwood.

Holes in metal are started with a dot from a center punch, but punching some plastic may break it. Instead a tool can be made by grinding the tip of a three-square (triangular) file to a point (Fig. 4-21B). This is rotated where the dot is to come to make a hollow to guide the drill into the right place. The ground end also makes a scraper. If it is drawn across most plastics, it will scrape away tool marks ready for fine sanding or polishing.

The abrasives used on wood and metal can be used on most

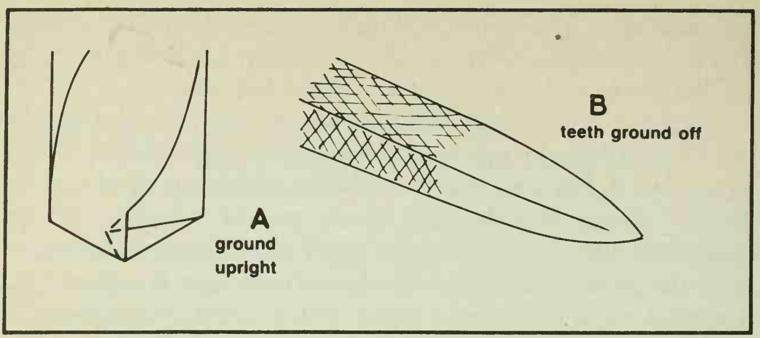
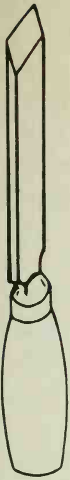
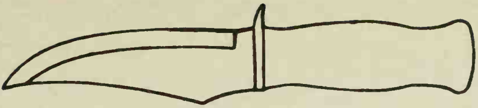


Fig. 4-21. A drill for plastic is modified at the cutting edge. A scraper made from a file marks hole centers besides scraping surfaces.

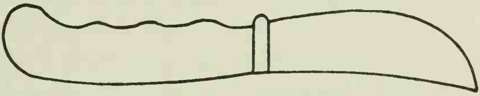
plastics, but it is better not to use a belt that has been used on metal in case dirt or metal embedded in it marks the plastic. Following wood abrasives is not s serious.

Most plastics can be brought to a good polish by buffing, but it is best to use a clean buffing wheel that need not be stitched. There are special compounds available for plastics. A problem is the effect of heat. Some plastics get soft is overheated. Excessive overheating may cause a breaking up of the surface. It cannot be put right, and the plastic has to be scraped. This means that buffing plastics should be done much more lightly than when working on metal, and the material should be moved about so that friction does not generate too much local heat. Holding the work away a little so it is in the draught of the revolving wheel is all that is needed to cool it.

Chapter 5

End-Sharpened Tools



The simplest knives and other tools to make and the ones that need the minimum equipment for hardening and tempering are those that cut on their ends. With only this small part of the tool needing to be brought to the correct temper, while the bulk of the steel can be softer, it is possible to do the heat-treating with a propane torch and a bucket of water.

Narrow-bladed end-cutting knives have many uses. One is needed for marking lines across the grain in woodworking. A similar knife is useful for cutting leather to shape, particularly in following around templates, as in making sheaths. Card mounts can be cut for pictures and similar things. Paper is cut to shape with one of these knives and a steel straightedge. At least one end-cutting knife is a useful tool to have on the bench or desk.

ADAPTED TABLE KNIFE

Broken or discarded table knives can be used, either with their existing handles or new ones. With the change of purpose it is usually better to make a new handle, if only to make the tool look less like a discarded table knife. As the blade is already hardened and tempered, it can be cut to the length required by grinding a groove across and snapping in a vise (Fig. 5-1A). The back and cutting edge can be ground to shape (Fig. 5-1B) and a preliminary bevel made on the end, but this should not be sharpened to a fine edge until after fitting a new handle. The ground edges can be

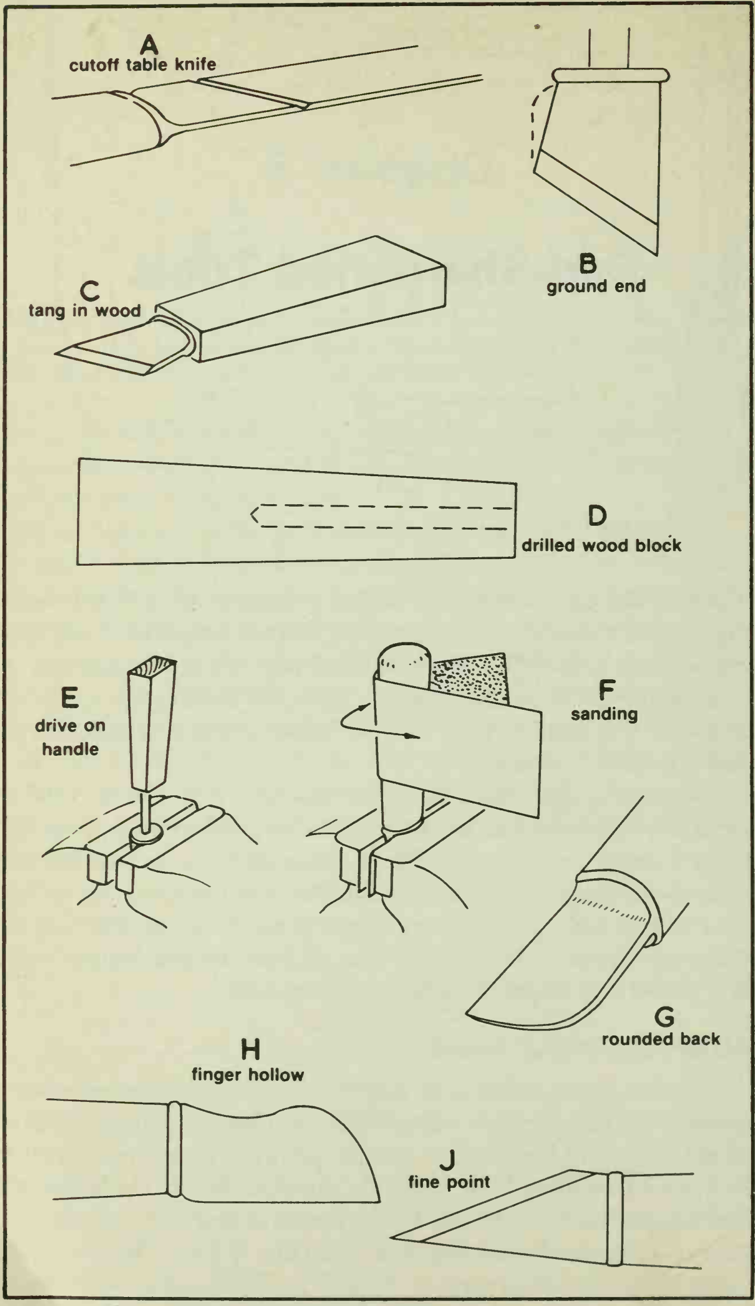


Fig. 5-1. An old table knife can be cut off to make a marking knife, using a drilled block of wood as a handle.

smoothed with abrasive paper and the blade polished.

Many table knives have a round tang to go deeply into a handle, with a shoulder between it and the blade. The size of this shoulder or bolster fixes the size of the end of the new handle, which can be a piece of close-grained hardwood. Cut it to a slight taper both ways to near the bolster size (Fig. 5-1C) and drill a hole slightly smaller than the tang (Fig. 5-1D). How much smaller depends on the wood and the tang. A rough, slightly tapered tang will grip in a larger hole than would be needed for a smooth, parallel one. Normally the hole goes deeper than the length of the tang, although if its end is pointed, that can be allowed to penetrate the end of the hole. An experiment with a hole in scrap wood may be advisable to arrive at the drill size to use.

Usually a good drive fit will have a firm hold, but it may help to smear the tang with epoxy glue. Grip the knife between soft metal guards in a vise and drive the handle on (Fig. 5-1E). It is wiser to do no more than the basic tapering of the handle at this stage. If the handle shaping is completed before fixing to the blade and the hole comes slightly out of straight, nothing much can be done about it, but if final shaping is left until after driving the tang, slight discrepancies can be corrected when finishing the handle.

For a small handle there is an advantage in making it a little too long at first. This gives something to hold while shaping the main part of the handle. When that is satisfactory, the excess wood is cut off and the top shaped. If a belt or disc sander is available, the handle section can be worked by rotating the wood against the abrasive, but allow for final lengthwise sanding to remove all signs of the cross grain scratches.

If the shaping is to be done by hand, sharpness can be taken off with a small plane. A block plane in one hand while holding the knife against a stop with the other hand is a convenient way of quickly bringing the section elliptical. The knife can then be held by its blade in a vise and strips of abrasive pulled around to smooth the shape (Fig. 5-1F). The top is rounded with a file, chisel, or Surform tool then brought smooth by sanding. What finish is given to the handle depends on its use, but two coats of varnish will seal the grain and give both a comfortable grip and an attractive appearance (Fig. 5-2).

The last job is sharpening the cutting edge. For some purposes it may be better to retain the original cutting edge and round the back of the blade (Fig. 5-1G). A hollow could be ground in the back for a finger to apply pressure (Fig. 5-1H). For dissecting and delicate

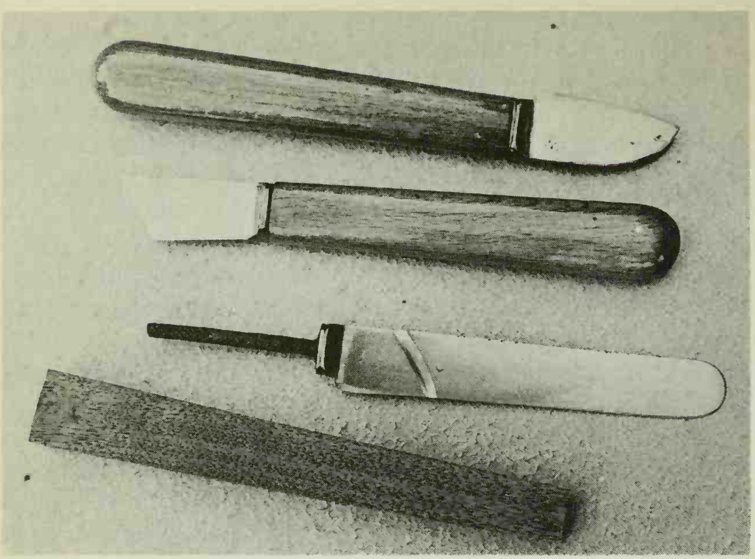


Fig. 5-2. Old table knife blades can be cut off to make carpenter's marking knives. A blade is shown scored with a grinding wheel. Its tang will go into a hole in the wood block below it.

work the cutting edge may be at an acute bevel to make a fine point (Fig. 5-1J).

SLAB-HANDLED KNIFE

New strip carbon steel can be made into knives for similar purposes to those adapted from table knives, as well as others. An extable knife tapers from the back to the original cutting edge, so that limits alterations to other designs. With new material of parallel thickness some other cutting ends are possible. Suitable steel is $\frac{1}{16}$ inch thick and $\frac{1}{2}$ inch or a little more wide.

A basic knife is parallel in the length, with an angled cutting edge and a handle made from two wood slabs held by two or three rivets (Fig. 5-3A). Mark and cut the steel to shape and drill the holes to the same size as the rivets (Fig. 5-3B).

Cut the wood for the two slabs. They may be made slightly too wide and long for trimming after fixing. It is possible to do shaping on all parts of the handle after fixing, except the ends of the slabs toward the blade. Round these ends down to the metal and smooth them with abrasive to a good finish (Fig. 5-3C). The other parts of the handle are better left flat until after riveting.

The rivet holes in the wood are best made by dealing with each side separately, using the tang as a template to drill through (Fig. 5-3D). One piece can be drilled then clamped with the other side in position for drilling the other way. It is important to see that the prepared handle ends toward the blade are exactly opposite each other.

Clean the surface of the steel on a belt sander or by rubbing it on abrasive paper. Deal with the edges as well. Grind or file the cutting edge almost to sharpness. Work with tools or abrasive is possible at this stage, but after hardening and tempering any shaping left to be done will be slower and more difficult, particularly near the cutting end. Polish the part of the steel that will be exposed beyond the handle.

Only the end of the blade is to be hardened and tempered to the correct hardness for cutting. The rest of the steel is softer. Use a torch and have a container of water nearby. Hold the handle end of the steel with tongs or pliers. There is no need to put the knife on a bed of coke or asbestos. Hardening and tempering can be done in the air.

For a two-stage heat-treatment, heat the end and up to 1 inch from it to redness, then plunge the knife vertically into water and move it about. Wipe it dry and rub the blade end bright again with abrasive paper for about 1 inch. Heat with the torch again, but do

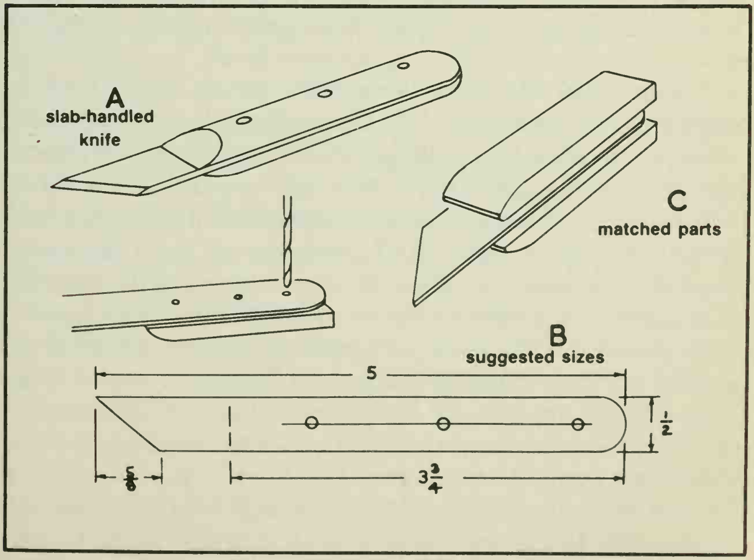


Fig. 5-3. A strip of steel can be made into an end-cutting knife by fitting wood slabs as a handle.

not let the flame go near the end. Direct it up to 2 inches from the end. Watch the colors spread along the bright part. Be careful of overheating. Heat and the colored oxides will continue to spread after the steel has been withdrawn from the flame. As soon as the straw color can be seen coming from the heated part along the bright part, hold the knife away from the flame and watch the end. The slower the spread of heat, the wider will be the oxide colors. If the steel appears to need more heat, use the flame only for brief flashes. Let the straw color reach the tip of the blade, then as it deepens there to a yellow-brown, quench the whole blade quickly in water.

For a single-stage heat-treatment, heat in the same place, but only punch the end, so there is still enough heat left in the body of the steel. Quickly brighten the end for at least 1 inch, with a piece of sandstone or other abrasive, then watch the oxide colors spread, as with the two-stage treatment. With thin steel the spread of heat is quite rapid, so for anyone with little experience, it is better to harden and temper separately.

Several types of rivets can be used, and some better ones for larger knives are described later. For this small simple knife, the rivets could be plain aluminum or copper, intended for metal. Copper nails can be made into knife handle rivets, but ordinary iron nails are too hard for riveting satisfactorily into wood. The diameter of the rivet should be slightly less than $\frac{1}{8}$ inch and the holes should match. Choose rivets with counter sunk heads.

Countersink the holes in one slab almost as much as the diameter of the rivet head. The head will pull in, so leave a small allowance for this. At the other side countersink a similar amount. Put all rivets through to check that the holes line up. Cut off the ends to leave an amount judged to be enough to fill the countersinks, with a little to spare (Fig. 5-4A). Support the rivet heads on a smooth iron block and use a light ball peen hammer to spread the ends (Fig. 5-4B). Work around the end of the rivet with light blows to get an even spread. Heavy blows may bend the rivet in the wood and weaken the joint. Continue in this way to spread the top to fill the countersink and stand up in a slight curve (Fig. 5-4C). Do the same with all rivets and check that the two slabs are tight to the tang and cannot be felt to move over it.

For this type of knife the rivets should provide all the grip needed, but in some knives the joint can also be glued with epoxy adhesive. The steel surface must be dry and without grease for this to bond properly.

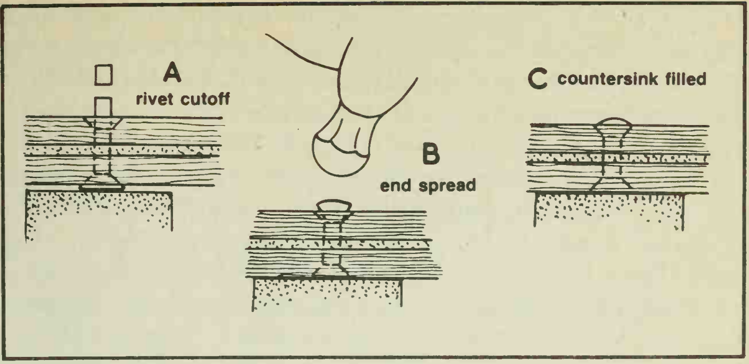


Fig. 5-4. A countersunk rivet is cut to length and its end spread with a hammer, while supported on an iron block.

With the handle slabs fixed to the blade, the wood may be shaped first to the outline of the tang and then curved to make a comfortable grip. A chisel and small plane may do some shaping, but there are the rivets as well as the edge of the tang that would blunt woodworking tools if they touched, so it is better to shape with a belt sander that will cut both wood and metal. If working by hand, the rivets may be filed level and shaping done with files or abrasive paper wrapped around wood and used like a file. Bring the handle to a good shape and finish it with lengthwise sanding before varnishing or using other treatment. Leave sharpening the edge until last.

Many variations on this design are possible. If the width of the steel is tapered back from the cutting end, it makes a neat knife for delicate work (Fig. 5-5A). The end can be given a double bevel so there are cutting edges both ways (Fig. 5-5B), providing alternative edges and possibly longer usage between sharpenings. The cutting edges do not have to be straight, and both back and cutting edge may be curved with anything between a near-straight cutting edge (Fig. 5-5C) and a very rounded back to a central end (Fig. 5-5D) or a very rounded cutting edge (Fig. 5-5E). A well-rounded edge is favored by leatherworkers for cutting with a rocking action.

It is possible to make the tool into a form of chisel by having the end square across and beveled on one side only (Fig. 5-5F). This would not do for heavy work, but for whittling or chip carving it is a good tool, and it is a useful desk pencil sharpener. The chisel end can be cut on the skew or rounded. A variety of light carving tools can be made in this way. If filed and ground hollow it becomes

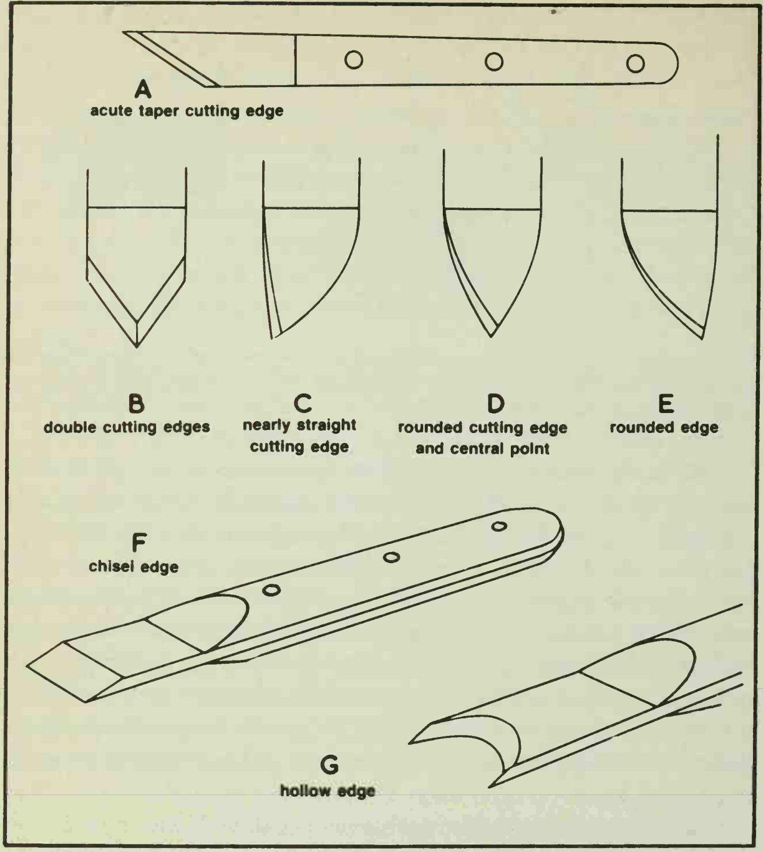


Fig. 5-5. An end cutter may have a tapered handle. Several knife edge shapes are possible, or straight and curved cutters for leather can be made.

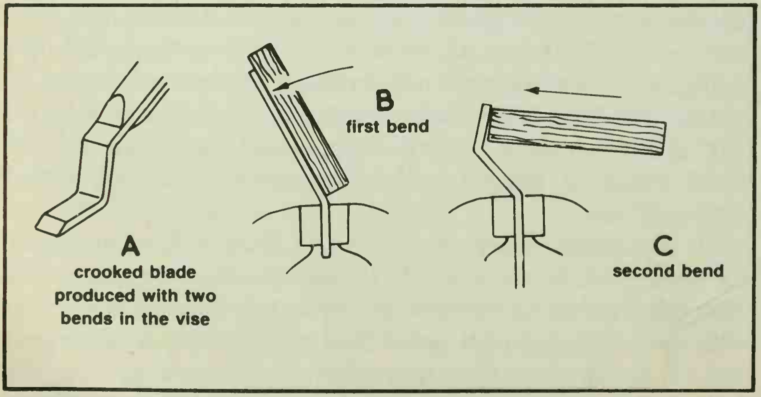


Fig. 5-6. An end-cutter can be bent or cranked by bending in a vise.

an edge-paring tool for leather (Fig. 5-5G).

For some of these light tools there is an advantage in cranking the end (Fig. 5-6A). Annealed steel of the size we are considering should bend cold. One bend is made by hitting or levering over with a piece of wood while the end is held in a vise (Fig. 5-6B) then the steel is reversed and bent the other way (Fig. 5-6C). If the steel is too stiff for this, it can be heated just to redness where the bend is to come; then it should bend easily. Do not quench the steel, or it will be hardened. If heat is needed to help bending, leave bending until all other shaping has been done so that this comes just before heat-treatment. If bends can be made cold, they can be done at any convenient point during work on the tool.

SCRIBERS

Round and square sectioned steel strip can be made into a variety of tools (Fig. 5-7), where the operative part is the end and hardening and tempering can be dealt with in the way just described for knives made from flat strip. The steel used may be anything from about $\frac{1}{16}$ inch upward. Quite small tools are useful for model making and other fine work. Many of these tools cannot be bought, so being able to make special-purpose tools is one advantage of a

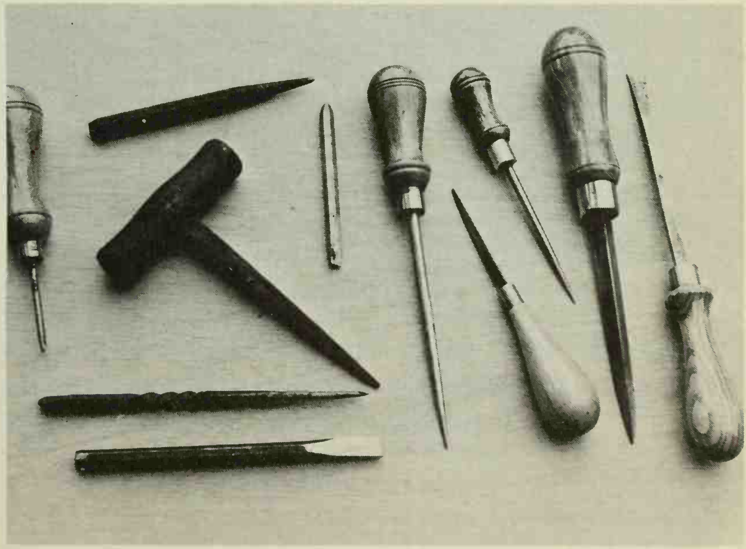


Fig. 5-7. Several end-sharpened tools: a brad awl, two punches, reamer, scriber, cold chisel, three awls, and two scrapers.

knowledge of simple knifemaking. For most of the tools described in this section round or square steel between $\frac{1}{8}$ inch and $\frac{3}{8}$ inch is appropriate, however.

It is possible to shape steel by filing and grinding, by forging, or by a combination of the two. Forging is the blacksmith's way of working metal, but in these light sections it is possible to work with an improvised anvil or block of iron on the bench and any convenient hammer. The difference between forging and filing is that the steel is still the same bulk, although a different shape, after forging whereas filing to shape removes metal and reduces bulk.

A scriber is the sort of thing that could be made either way. In its simplest form the end of a steel rod is filed or ground to a taper (Fig. 5-8A) until a satisfactory shape is obtained. This is polished bright and the point hardened and tempered.

If the point is to be forged, there is an advantage in keeping the steel strip long so that the extension can be used as a handle. It is cut to length later. If a short piece is used, it must be handled with tongs. To *draw down* a point, the end is brought to a red heat

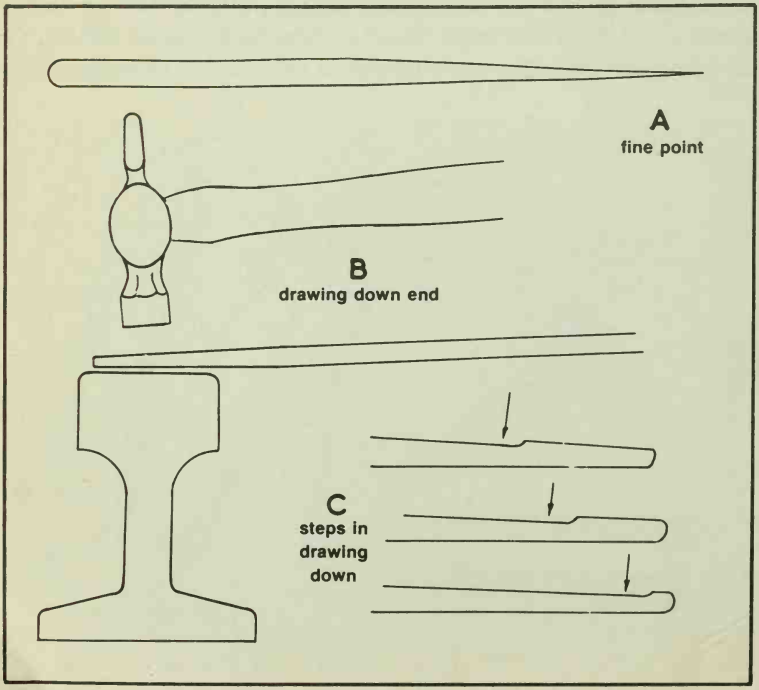


Fig. 5-8. A point may be forged by heating to redness and hammering to stretch the steel in the length.

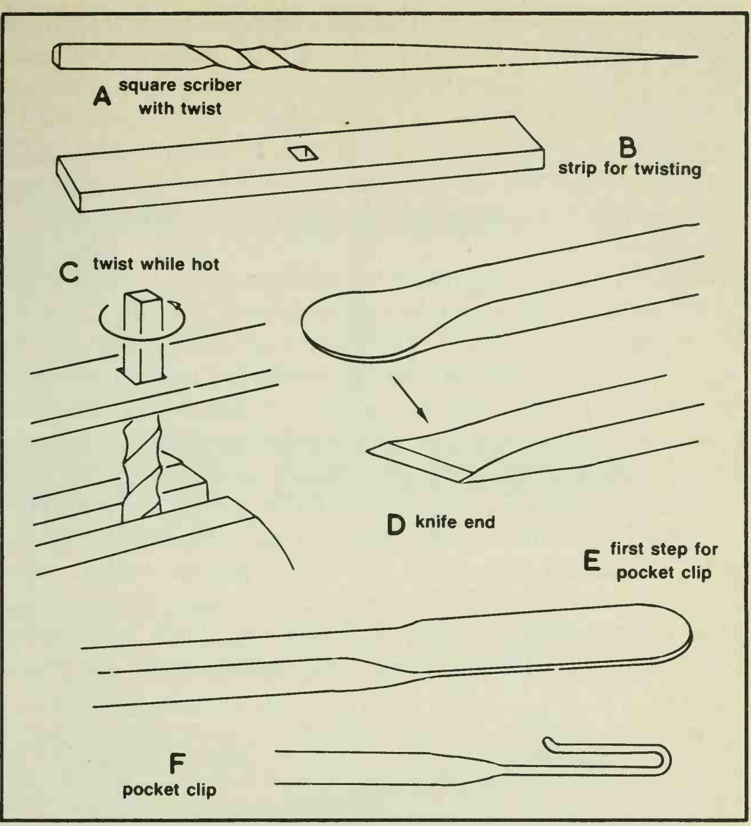


Fig. 5-9. A pointed tool can be decorated by twisting after heating. Its end can be flattened to make a knife or pocket clip.

then hammered on an anvil or iron block with one hand while the other hand holding the steel rotates it between blows (Fig. 5-8B). Blows are applied in a series starting from near where the limit of the taper is to be and progressing toward the end (Fig. 5-8C). The effect is to stretch the steel as well as reduce its thickness toward the point. Reheating and hammering in this way could be continued until the steel is drawn down to a fine point. If the scriber is to finish bright, there has to be an allowance for filing or grinding, so the end is not taken completely to a point.

Forging to shape affects the state of the steel. Do not dip the steel into water at any stage. When all forging has been done, anneal the steel by heating it to redness and leaving it to cool as slowly as possible.

If square steel is used for a scriber it can be given an interesting appearance by twisting its center (Fig. 5-9A). This also serves as a grip. A tool is needed to grip the steel for twisting. Although it could be done with pliers or tongs, it is easier to get an even twist with a two-handed tool. A two-handed wrench, intended for screwing taps, is a good tool, providing its adjustment can be made to fit the square steel. A simple alternative is a strip of iron or steel with a square hole that can be made by filing through a drilled hole (Fig. 5-9B).

Heat the part to be twisted to a uniform redness. If it is hotter at the center, the twist will be tighter there (Fig. 5-10). Try to get an even heat for the length to be worked and a little more. Put the strip upright in the vise and slip the twisting tool over it to the point where the twist is to come. Immediately, before the adjoining steel cools the work, twist the steel to a spiral you like the look of—probably three-quarters of a complete turn (Figs. 5-9C, 5-10, 5-11).

An additional piece of work may be the making of a knife edge at the end opposite the point. Heat that end to redness and spread it by hammering (Fig. 5-9D). See that it finishes central. After annealing, this end can be filed or ground to shape. Such a scriber looks attractive if the central twisted part is left black from forging, then the two ends are filed, sanded, and polished bright, before and

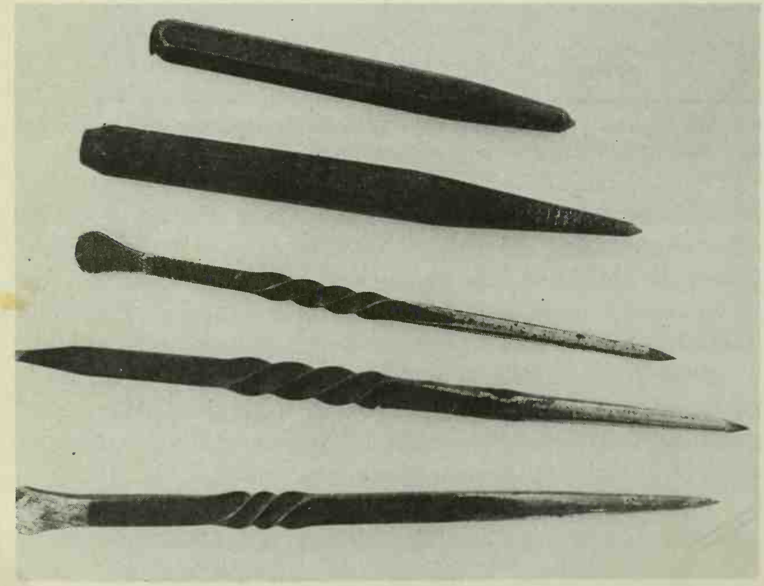


Fig. 5-10. Two punches and three scribers—the bottom one shows a tighter center twist because of uneven heating.

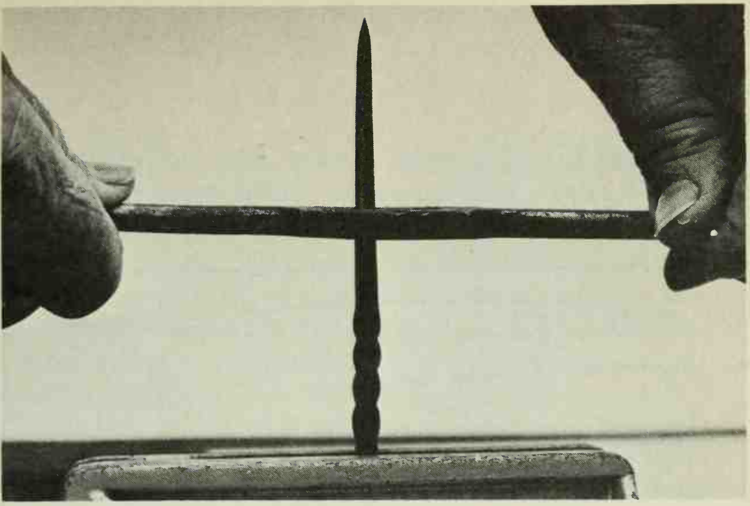


Fig. 5-11. With the steel in a vise the twisting tool is quickly brought down to the red hot part and the twist made swiftly.

after hardening and tempering.

A slightly more advanced piece of forge work, but still possible with simple equipment is to hammer the end opposite the point to a uniform thinness for about 2 inches. There may have to be some

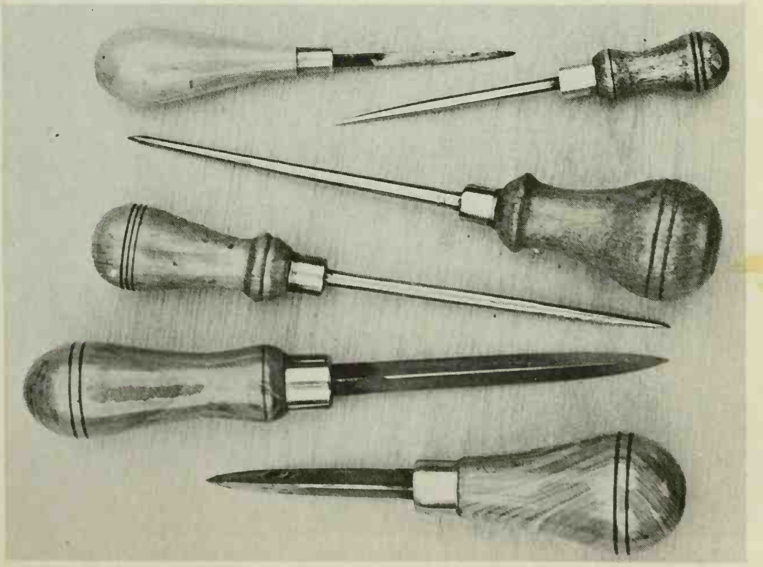


Fig. 5-12. Three round awls and three made from triangular files.

filing to make it parallel (Fig. 5-9E). Then it is heated and bent back over an iron rod to make a clip for a pocket edge (Fig. 5-9F).

AWLS

A handled point is useful in many activities. If a lathe is available the round handles common with these tools can be made (Fig. 5-12). Otherwise, handles intended for files and other tools

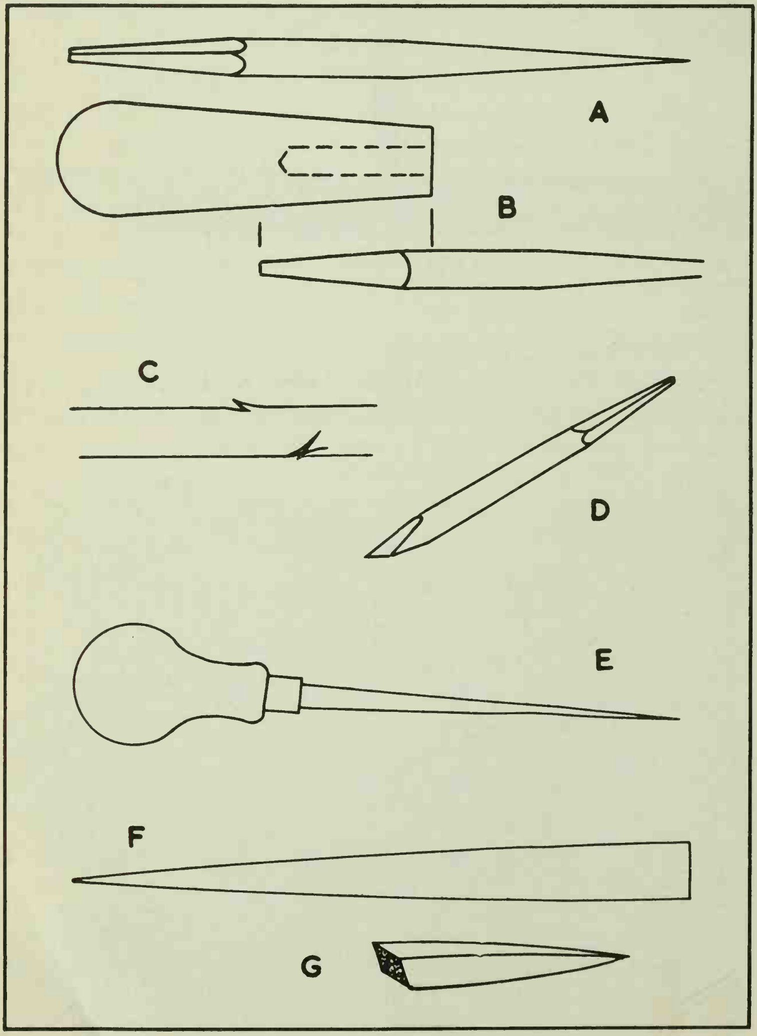


Fig. 5-13. An awl may be given a tapered end to fit a handle, with teeth raised to increase its grip.

can be bought and used. The handles for many awls can be just tapered pieces of hardwood.

A light awl is a tapered point, made by filing or forging. The other end is given a square taper (Fig. 5-13A). This taper need not be very long—about four times the diameter of the rod is about right. The hole in the handle is made slightly undersize and only deep enough to allow most of the square taper to penetrate farther into the wood (Fig. 5-13B). For leatherwork, piercing paper, and similar light uses, this construction is all that is needed. An awl with a rounded end, is needed for decorative work on leather.

Epoxy glue may be smeared on the tang when it is fitted. Another way of strengthening the joint is to raise teeth on the steel with a cold chisel (Figs. 5-13 and 5-14) so that they rip the inside of the hole. Making cold chisels is described later in this chapter.

Instead of taking the awl to a point, one can be made as a brad awl for pushing small holes into wood. This should be round steel rod about $\frac{1}{8}$ inch diameter. Its cutting end is filed on both sides to give a knife edge across the end (Fig. 5-13D). It is inadvisable to leave an awl tempered too hard. The oxide colors should be allowed to continue until the end is into the purple range. This type of brad awl is without a bolster where it enters the handle, so it is only suitable for light work. The handle should not be hit, but

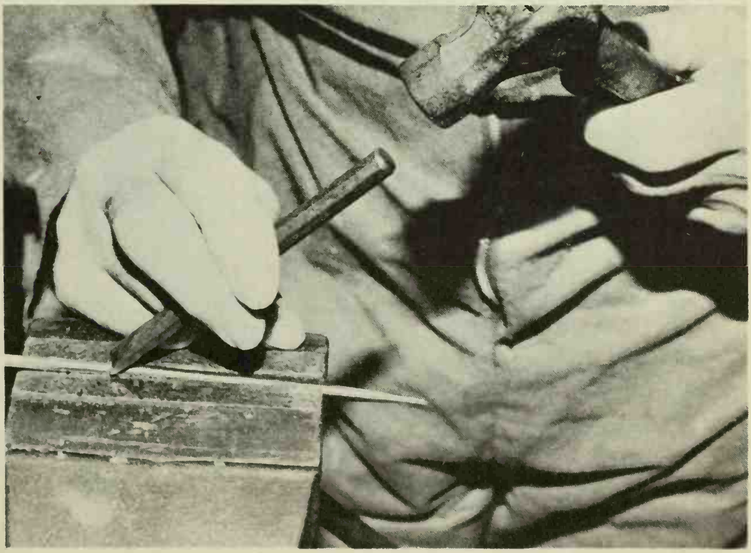


Fig. 5-14. Raising teeth on the tang of a tool, to grip the wood as it is driven into a hole in the wood handle.

it will make holes for woodscrews in most types of wood.

A longer type of awl is an ice pick (Fig. 5-13E). It can be forged like a scriber and given a square tapered tang to fit in a handle. The same tool can be used as a spike for splicing ropes, but the proper seaman's marline spike is without a handle, so it can be driven right through between rope strands if necessary (Fig. 5-13F). The point is best forged on the end of a round rod about $\frac{3}{8}$ inch diameter then ground and polished before cutting off and the top shaping.

Upholsters and leatherworkers use an awl with a diamond cross-section and a taper to a point (Fig. 5-13G). The edges act as cutters to break away fibers and enlarge a hole as the tool is thrust through canvas or leather. The section can be ground or filed on the end of a rod then finished in the same way as an ordinary awl.

CHISELS AND PUNCHES

Metal-cutting cold chisels and punches for marking metal, sinking nails, and doing decorative work on wood and leather all have their vital parts at their ends, so they can be hardened and tempered in the same simple way as other tools in this chapter. Square and round steel rod can be used, but hexagonal and octagonal rod is more useful, because the shape provides a good hand rip when these tools are hit (Fig. 5-15).

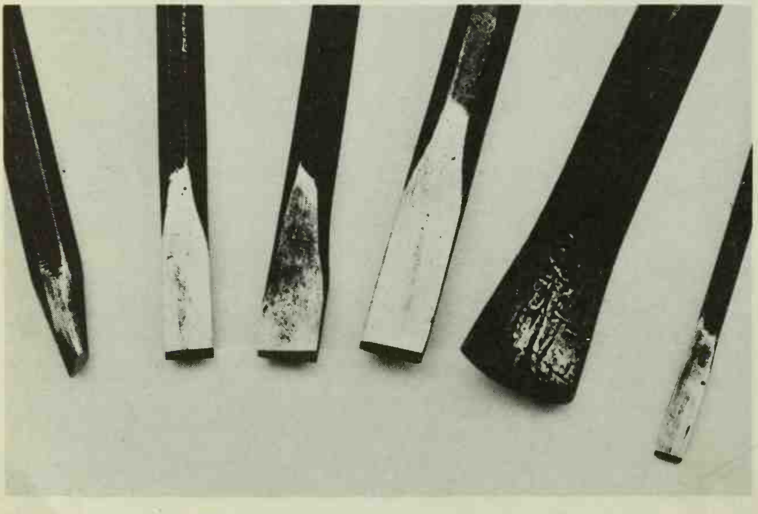


Fig. 5-15. Four chisels made from octagonal bar, a large one made from round rod, and a small one from square rod.

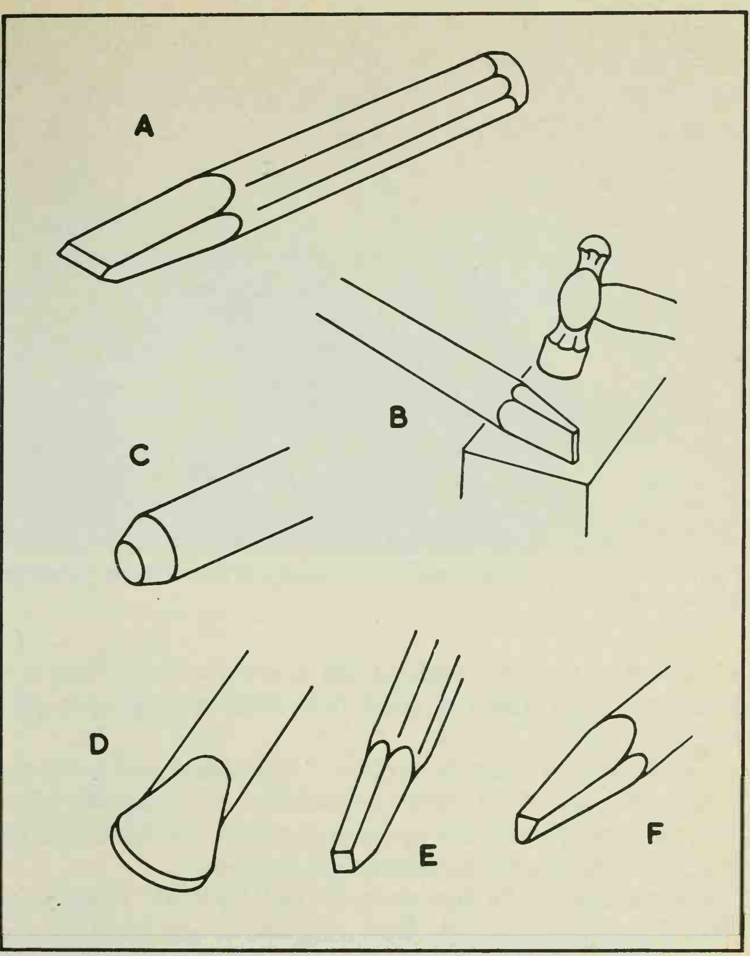


Fig. 5-16. Cold chisels are forged from round or hexagonal steel and may have various shaped ends.

A cold chisel has a tapered end. Its cutting edge is sharpened at about 60° (Fig. 5-16A). Many sizes are possible and the work in making any size is the same, but the larger ones involve heavier work, particularly in forging the ends. For a simple hammer and iron block method, rod about $\frac{3}{8}$ inch across is a reasonable maximum size.

The end of a rod is drawn down to a flat taper, almost to a thin edge (Fig. 5-17). Besides hammering it to thickness progressively toward the end, occasional blows are given to the width to keep it parallel (Fig. 5-16B). By careful hammer work on the hot steel

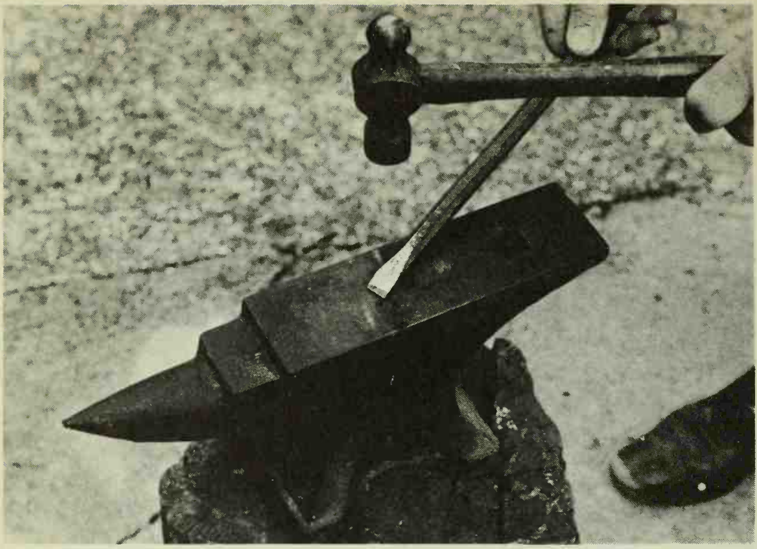


Fig. 5-17. The end of a long rod is hammered to a chisel shape before the rod is cut to length.

and checking that the resulting end is straight and central, it is possible to get a taper that needs little filing or grinding to get a satisfactory shape.

It is usual to leave the body of a chisel black and polish the taper to the point. Work this to a smooth flat taper on opposite faces, with the edges parallel and square to the faces. The actual cutting edge is left until after hardening and tempering.

A cold chisel is hit directly on the end. Its length should be at least 5 inches so that one hand can hold it and leave the top projecting for hitting. The top is not hardened and tempered. If it were, it might damage the face of the hammer. It is usually ground all around with a tapered edge (Fig. 5-16C) to limit the amount of spreading due to hitting.

For general purposes a cold chisel should not be too hard. A hard cutting end will break. Temper to the stage where the edge is just beginning to turn purple. Grind the cutting edge to about 60° for general use. If the chisel is only to be used on brass or other soft metal, it can be slightly more acute.

That is the common cold chisel, which is needed more than any other, but anyone wanting to make a set, can include other shapes. An end can be curved (Fig. 5-16D), but the chisel is otherwise made in the same way. A *cross-cut* chisel (Fig. 5-16E) will chop grooves in metal; one with a curved cross-section (Fig. 5-16F) will chop hollows. These last two are forged with square tapered points then ground to shape.

Hole positions on a metal surface are located with a center punch dot, into which the point of the drill can be entered for a correct start. Center punches have round tapers and round points (Fig. 5-18A). The point may be no more than $\frac{1}{16}$ inch across for light work or as much as $\frac{1}{4}$ inch across on a large punch for heavy marking. The point may be about 45° for careful locating of dots on soft metal, but it has to be broadened to 60° or more to stand up to hitting into iron and steel (Fig. 5-18B).

It does not matter if the taper is not perfectly circular when it is drawn down. It will function just as well, although it will look better if round. Draw the point down in the same way as a scriber,

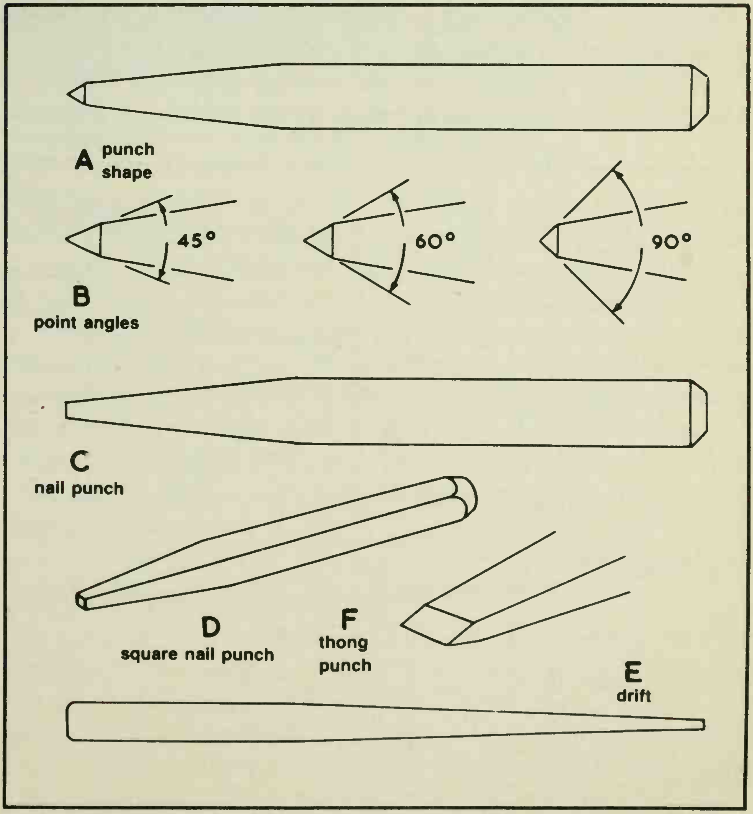


Fig. 5-18. A punch may have a tapered point for marking hold positions or be flat for driving nails or pins, or have a cutting edge for slots in leather.

but not with such a long taper. Clean the shape of the taper with file, grinding, and abrasive paper. Bevel the top that will be hit in the same way as a cold chisel. Temper just into the purple, in the same way as for chisels.

Nail punches can be made in the same way as center punches, except the ends are ground square across (Fig. 5-18C). As the punches have to drive nail heads into the wood, they need to be in several sizes to suit nails, from about 1/16 inch upward. Besides round nail punches there are some with square or rectangular tapers (Fig. 5-18D). They can be made from round, or octagonal, or square stock. The taper has four sides at right angles to each other, with the sharpness of the angles taken off in final shaping.

Another punchlike tool is a drift. This is a long tapered piece like a nail punch (Fig. 5-18E). Its purpose is to thrust into two holes where metal parts do not line up as they should, and it is levered to get them in line. It could be made of carbon steel and left without hardening and tempering.

There are punches used for making holes for thongs in leatherwork, as sometimes arranged around the edge of a sheath.

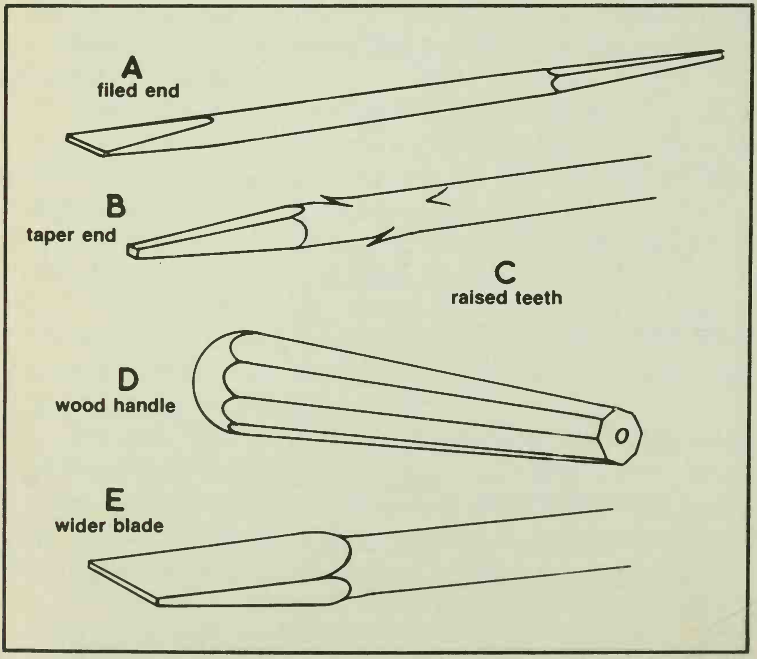


Fig. 5-19. A screwdriver end may be filed or forged and have teeth raised on its tang to prevent twisting.

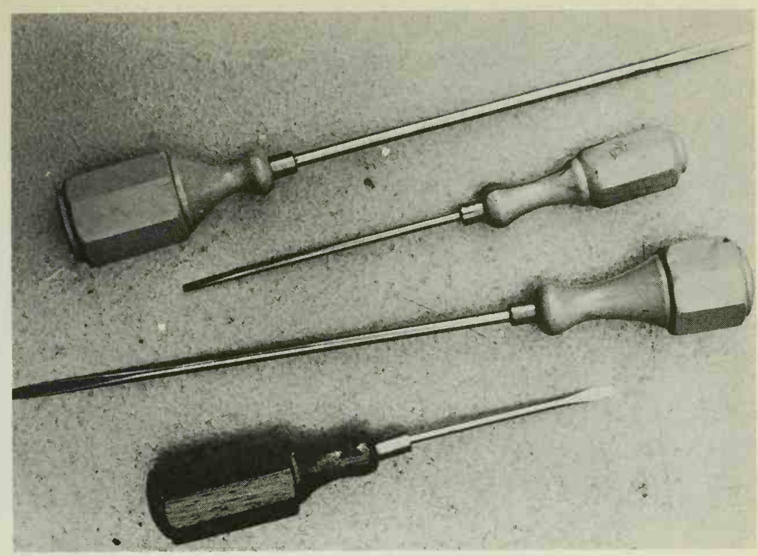


Fig. 5-20. Screwdrivers made from round rod. The top three were filed, but the bottom one was forged to make a wider end.

The tapered end is square or rectangular and taken to a rather thinner end than for a nail punch. The width of the end suits a thong (probably about $\frac{1}{8}$ inch), and the tool is given a cutting edge (Fig. 5-18F) to pierce the leather. Temper to a medium brown.

Punches used for decoration of backgrounds in leatherwork and wood carving are round or square rods, with their ends filed squarely across. The decoration is made by filing grooves across or otherwise making a pattern on the end, the reverse of what is wanted on the wood or leather. The end may not be given heavy use, but the pattern must keep its clean outline, so temper fairly hard, to deep straw.

SCREWDRIVERS

Large screwdrivers have to be shaped where they fit into their handles to resist torque, but for light screwdriving, such as in electrical work and in driving woodscrews up to about $\frac{3}{16}$ inch diameter screw heads, it is satisfactory to make the blades with square tangs to engage with holes in wooden handles. The blades may be square or round rod. The simpler type has the blade parallel throughout.

The end of the rod is filed to a taper on each side of the end

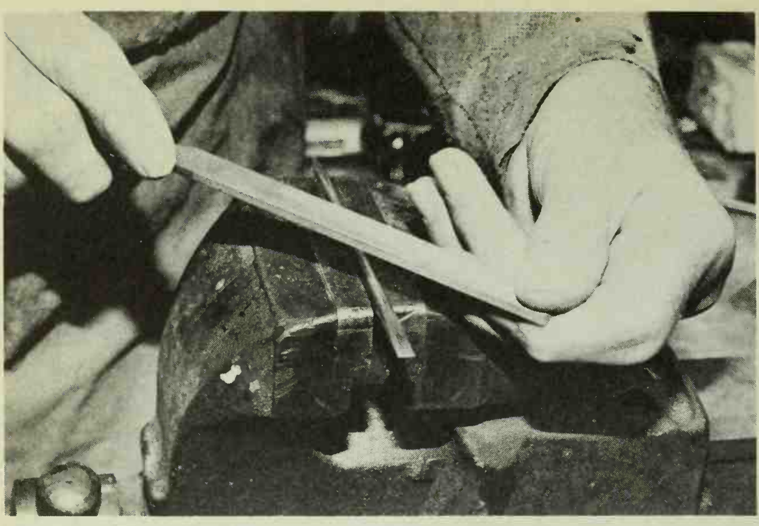


Fig. 5-21. Filing the taper on a screwdriver.

(Figs. 5-19A and 5-21). The actual thickness to be left at the end is best found by checking against the slot of a screw of about the same diameter head as the screwdriver. The other end is filed to a square taper (Fig. 5-19B), as described for the awls. There can be teeth raised by chopping the tang with a cold chisel (Fig. 5-19C).

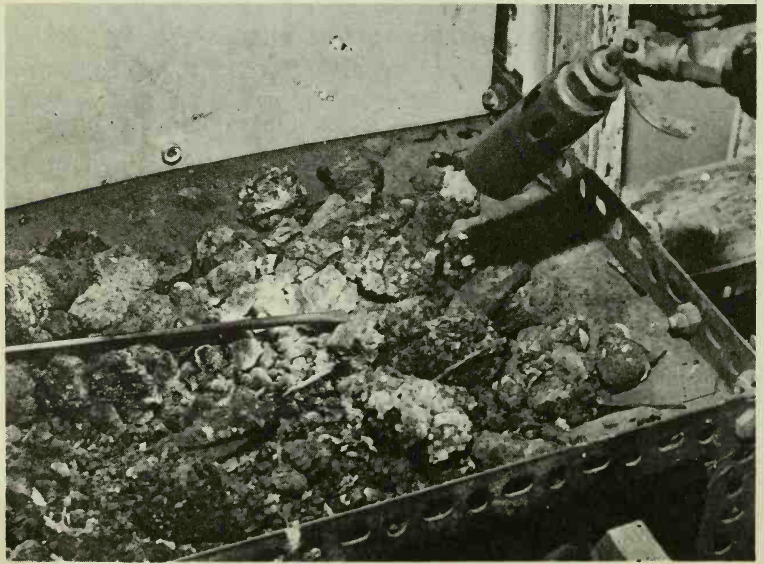


Fig. 5-22. Resting the end of a screwdriver rod on a bed of coke speeds heating.

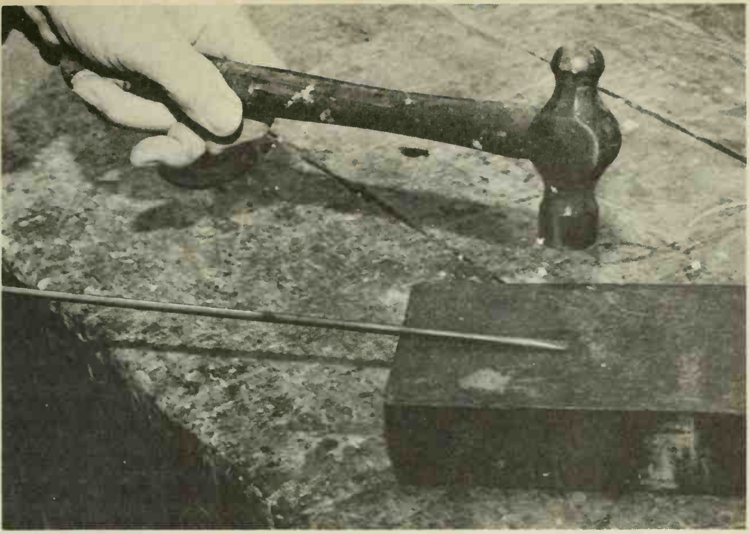


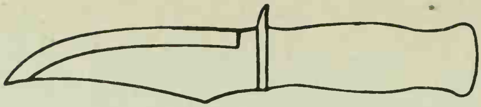
Fig. 5-23. The red hot screwdriver end can be spread by hammering on an iron block.

Several screwdrivers can usefully be made in different lengths and within the size limits suggested.

Handles should be of a type that provide a grip when the hand is turning them. If a lathe is available, they can be turned from wood prepared by planing octagonal pieces (Fig. 5-20) so that a part can be left to form a grip. Alternatively, tapered square handles can have their corners planed off to give an octagonal section (Fig. 5-19D). Coating the tang with epoxy glue when it is driven will also help to resist torque when turning screws.

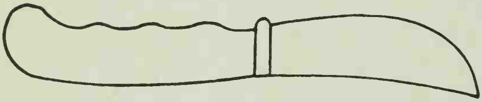
A parallel screwdriver blade is particularly useful when it has to follow a screw head down a hole. Another type has the tapered tip slightly wider than the parallel shaft behind it (Fig. 5-19E). This is made by forging, instead of filing, the taper so that the steel broadens as well as thins (Figs. 5-22 and 5-23). The forged shape is trued by work with a file or by grinding.

The load on a comparatively narrow end of a screwdriver means it has to be as tough as possible so that its corners do not crumble and hard enough so that it does not buckle. This means a compromise in tempering, but a screwdriver has its end tempered softer than cutting tools, and it should be taken into the blue. The heat travels along, and all the oxide colors should be allowed to reach the end. Tempering should be stopped when blue has reached the tip.



Chapter 6

Plain Knives



Many useful knives can be made without a bolster or guard. The blade continues as a tang into and usually through the handle as one smooth flat piece of steel to give ample stiffness for many purposes. A knife intended for heavy duties should have a bolster, and for some types of cutting this is better extended to form a guard. Knives of those types are described later in this book.

In some cases, knives of a particular class may be satisfactory for light duties without a bolster, but similar knives expected to be given heavy work are better with a bolster. This applies to many butcher knives. A bolster provides some stiffness at the change from blade to handle. In general, a plain knife is better made of thicker steel than one without a bolster. Carried to an extreme, a tool like a butcher's cleaver may be nearly 1/4 inch thick at the back and tang. There is enough stiffness in this for the tool to be made without a bolster, although some cleavers are made with one for the sake of appearance. At the other extreme, a small scalpel or dissecting knife may be quite thin and flexible, but because of its light duties, it will still be strong enough without a bolster.

Vegetable knives, kitchen utility knives, many butcher and carving knives, boning and chopping knives, bread and sandwich knives, leatherworking and paper trimming knives, as well as bench knives for several trades can all be made in the plain style. Some suggested sizes and shapes are shown in (Figs. 6-1 and 6-2). A

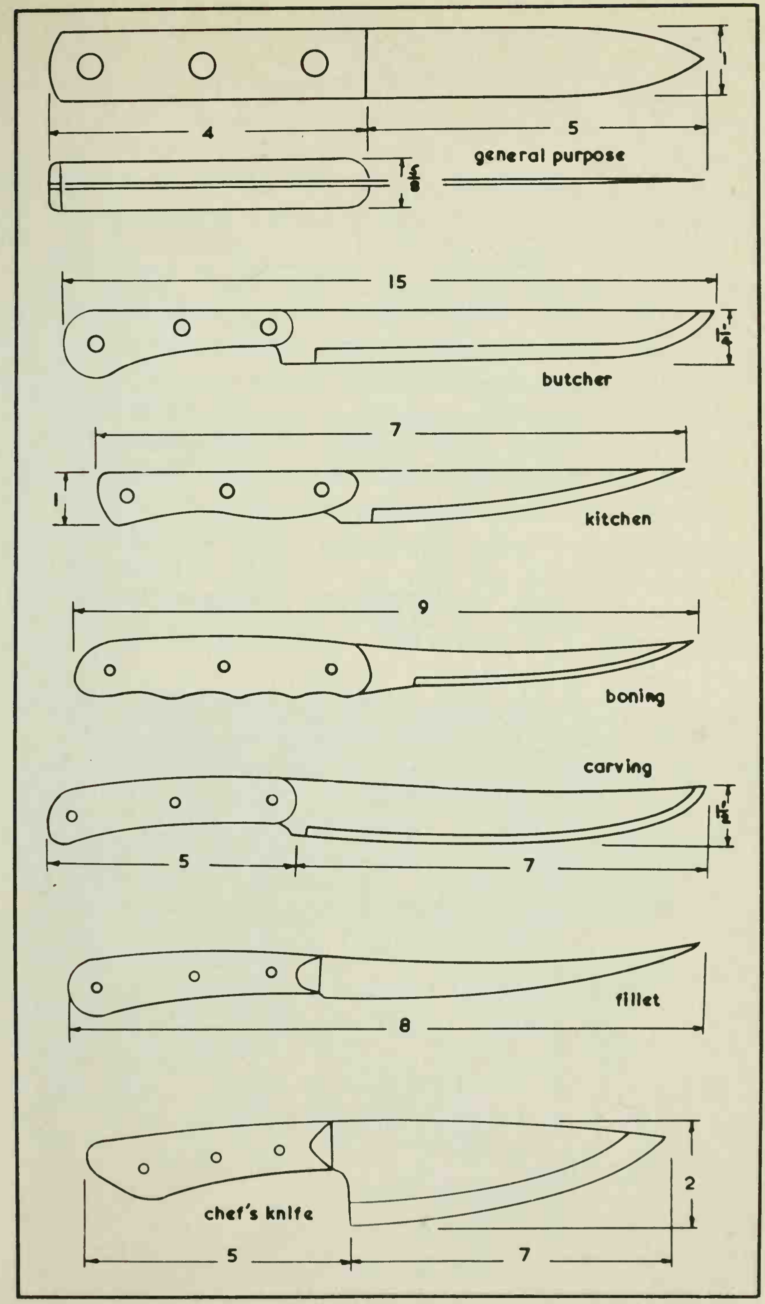


Fig. 6-1. Some types of full-tang knives without bolsters or guards.

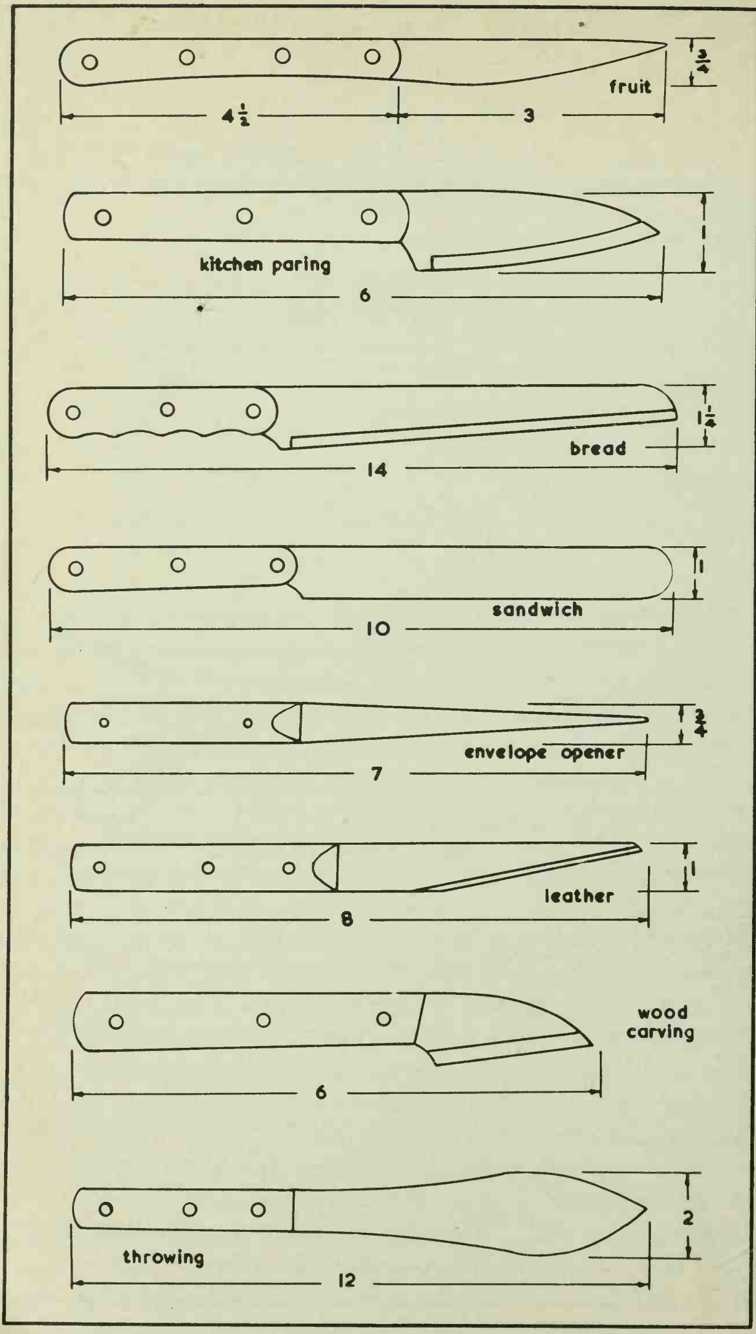


Fig. 6-2. More types of full-tang knives without bolsters or guards.

reasonable thickness of steel to consider for many of the knives is about $\frac{1}{16}$ inch. If steel recovered from old saws and other previously used sources is to be made into knives, thickness should usually be proportional to size, although a short heavy-use knife obviously needs thicker steel than a larger one for more delicate use. The handle end does not have to be tempered, but carrying the knife temper a short distance into the handle gives strength where it is needed.

How the steel is marked out depends on the method of cutting. The most accurate line is a scratch from a steel scriber, but this is not easy to see. There is a dye, usually sold as *engineer's blue*, that can be painted on the surface so scratches show up better. Another way is to wipe a wax crayon over the scriber lines so some of the wax is trapped to make the lines visible. If the steel is to be burned to shape with a cutting flame, the first outline has to be far enough outside the final shape to allow for removing the rough edge left by the cutting torch. Going over the steel with a smoky flame to darken it may allow the intended outline to be marked in the soot with a pointed stick. A marking pen on the clean steel may also give a guide to the cutting torch. Flame-cutting is

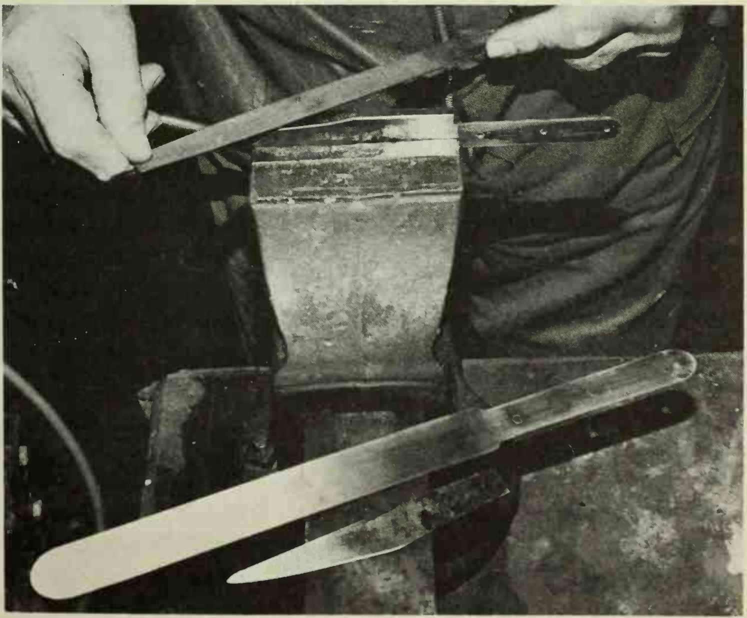


Fig. 6-3. Filing a hunting knife blade to shape. Steel for palette knife and a utility knife are on the end of the vise.

a roughing-out operation, and the line to be worked to should be scratched with a scriber afterwards.

SHAPING

Cut the steel to shape (Fig. 6-3). Fully annealed steel may be sawn and filed, but much shaping can be done less laboriously by grinding. If the first outline has been flame-cut, the rough hard edge the heat produces will have to be ground away as far as the unaffected steel before filing becomes possible. With a grinding wheel the steel can be manipulated on the tool rest (Fig. 6-4A). This is easier to control than doing it freehand without a support (Fig. 6-4B) although outlines can be formed that way on a belt sander. A disc sander with a rest in front of it can also shape steel, but the speed with which the abrasive grit passes the steel is obviously higher near the circumference than near the center, so cutting should be kept there (Fig. 6-4C). Experience will show how much of the disc can be used properly. Going too far toward the center will cause rapid wear of the disc, with little removal of steel.

Any of those methods of grinding will shape straight edges or convex curves. Hollows may be filed with round or half-round files, but much of the waste can be removed with the corner of a stone (Fig. 6-4D). If a belt sander is adjusted so that the belt runs over one edge, it can be used in a hollow (Fig. 6-4E). It is also possible to have a disc sander with the abrasive disc bigger than the backing piece, so its edge can be used in the same way. If a wooden backing disc is made with a rounded edge, this design will support the disc under pressure and get a better and quicker cut (Fig. 6-4F). In both cases the belt or disc should have the grit on a good cloth backing, or it will quickly break or fray on the edge under pressure.

Where the concave curve is a long sweep, as in a clip (Fig. 6-4G), grinding may not be a very accurate way of shaping, although it can be taken close to the line and a finish obtained with sweeping strokes of a large half-round file. Finger grips (Fig. 6-4H) are probably better finished to shape by filing. If the steel tang is brought to a good shape, it will serve as a template for the shaping of the slabs. This is a better way than leaving final shaping of both wood and steel until after assembly.

Holes for rivets may be burned through or drilled. If they are flame-cut, this is best done when the outline is cut, so the raggedness produced on the surface can be ground off at the same time that the edges are ground. These holes may be far from round, but that does not matter so long as there is clearance for the rivets

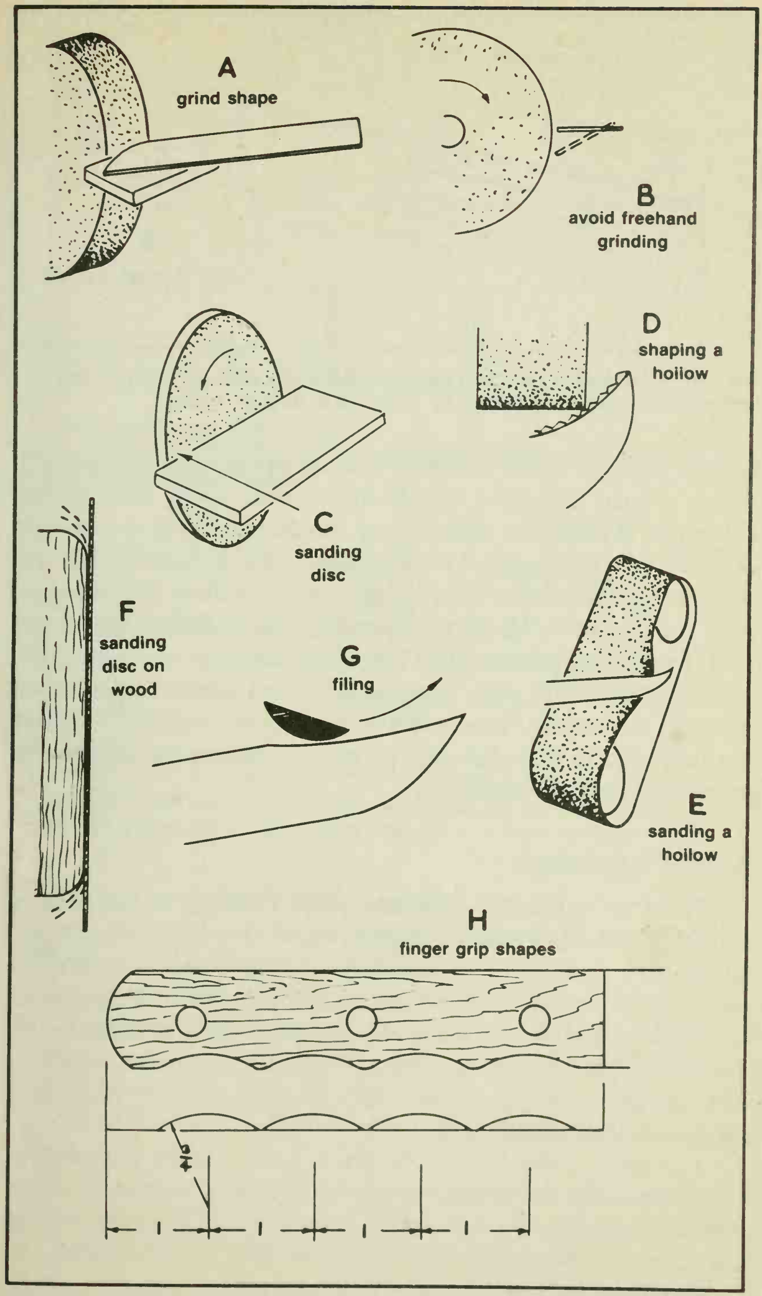


Fig. 6-4. Blade shaping can be done on stones, discs, and belts or by filing. Finger notches can be equally spaced on the tang and handle.

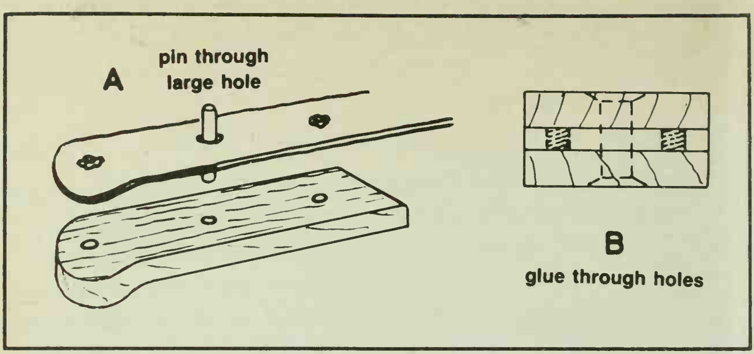


Fig. 6-5. A burned or punched hole may be larger than the rivet or pin, and additional security is provided by epoxy glue through holes.

to pass through at the intended spacing in the slabs (Fig. 6-5A). Space around the rivet will be filled with epoxy glue during assembly. If holes are drilled, they should match the rivets. Aim at an easy fit. It should not be necessary to force the rivet through.

As epoxy glue has a very tight bond to almost any material, extra security to the handle slabs can be given by drilling some more holes in the tang (Fig. 6-5B). When the handle is assembled, the holes are filled with glue, which sets to form a sort of epoxy rivet between the slabs. These epoxy rivets are not essential because the metal rivets and glue applied to the surfaces should provide more than enough strength.

BLADE GRINDING

Many knife blades are tapered from the back to the edge in section (Fig. 6-6A). A flat taper gives the finest edge, but not a very strong one. Letting each face follow a slight curve carries the thickness of the back farther into the blade for stiffness and gives an edge that is slightly thicker and, therefore, stronger (Fig. 6-6B). For a fully tapered blade, for most purposes, this is a better section. The straight taper to a very thin edge is only for maximum sharpness and delicate cuts.

For many purposes it is better to have a blade section that remains parallel for perhaps one-third of the width from the back and then has a straight taper to the edge (Fig. 6-6C). The thick part provides stiffness. If the blade is only about $\frac{1}{16}$ inch thick, the dividing line between the flat and the tapered part may not be very clear. That does not matter, except for appearance. If the steel is thicker, the taper may be made slightly hollow (Fig. 6-6D). This

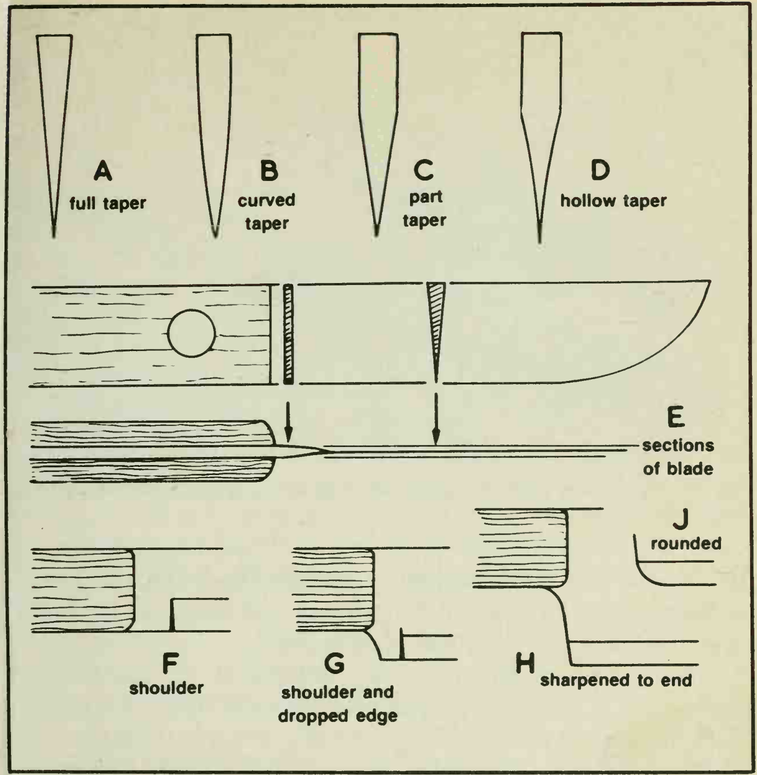


Fig. 6-6. Blade sections depend on thickness and purpose. Cutting edges may stop at a shoulder or be carried through at a dropped edge.

gives a more acute cutting edge and allows for later sharpening to be carried farther back at about the same angle, more than would be possible with a straight taper.

In some knives the tapered part of the blade blends into the parallel part that forms the tang without a definite break. The cutting edge ceases a short distance ahead of the handle (Fig. 6-6E). The result is the avoidance of an abrupt change of section, considered to give the greatest resistance to breakage between blade and handle.

Not having an obvious end to the cutting edge may be a nuisance in using the knife, and it is more common to incorporate a shoulder a short distance ahead of the handle (Fig. 6-6F) in all but the thinnest knives (Fig. 6-7). It may be found in a dropped edge blade (Fig. 6-6G), as the shoulder provides some protection to the hand, particularly if the drop is not very much. With a deeper drop

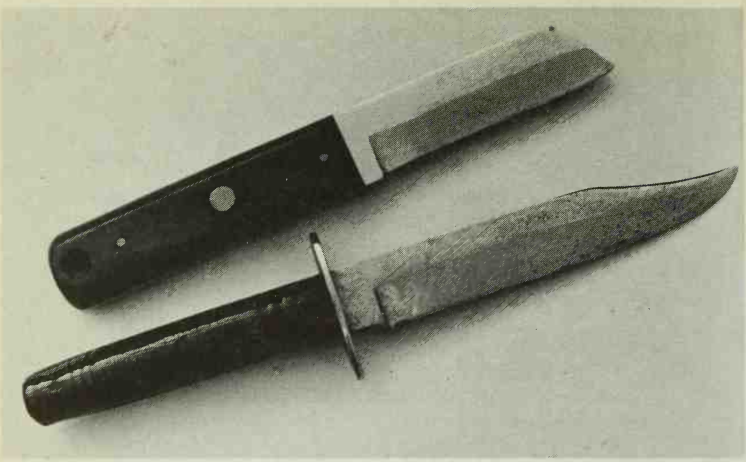


Fig. 6-7. Two knives, showing the shoulders where the taper to the cutting edges stop near the handle.

the cutting edge may be taken to the end (Fig. 6-6H) without risk of the sharp corner coming into contact with the hand, or if there is any doubt, it can be rounded (Fig. 6-6J).

The actual grinding is very dependent on practice and experience. It may seem simple to reduce the blade to a taper in thickness, but it is difficult to keep this uniform throughout the length of the blade. Choosing a short-bladed knife as a first project is a good idea.

Grinding should be done on a grinding wheel. There may be later uses for a belt sander or a disc, but the early removal of metal is better done on a wheel. The larger its diameter, the easier it will be to produce a regular taper, but even with the common 6-inch double-ended grinder, a good shape is possible. So far as you can, work along the length of the blade without stopping. Do not try to get the taper in sections, as this will almost certainly cause unevenness in the length. Sweeping along the blade will keep each grinding stroke the same all the way. If the knife finishes with any unevenness in its width, this will be less apparent than uneveness in the length. By examination and feel you will check how the beveling is going. The curve of the stone will cause a series of ridges (Fig. 6-8A). Concentrate at first on removing metal then try to get the ridges overlapping so that the smaller ridges are less obvious (Fig. 6-8B). Sweeping the blade along with a slight rocking motion will also reduce ridges.

Parts that could be troublesome are close to the handle, where you are liable to press harder and may get the taper thinner, and at the tip, if it is a fine point, where it is easy to remove too much metal. Concentrate on the main body of the blade and blend the ends in without excessive pressure there. Do the same on both sides. The easiest section to work is the slightly convex one. First steps are hollow grinding near the edge (Fig. 6-8C). Work back from the edge so that more ridges follow back (Fig. 6-8D). Return to the edge and grind more and make more strokes across, overlapping the previous ridges (Fig. 6-8E). Do the same on both sides.

If a knife can be brought lengthwise to the stone, there can be strokes to get rid of many of the ridges. It may help to support the blade with a strip of wood (Fig. 6-8F). Do not hold the blade still at any one spot, but keep it sweeping up and down and moving about, with frequent examination to watch progress. Grinding this way should only be enough to remove the crosswise ridges. Actual shaping should have been brought close to the intended section by the sweeping grinding cuts along the blade held across the stone.

A straight taper for the full width of the blade is tackled in the same way. Check across the blade frequently when getting near the shape with a straightedge. It is possible to get the many small

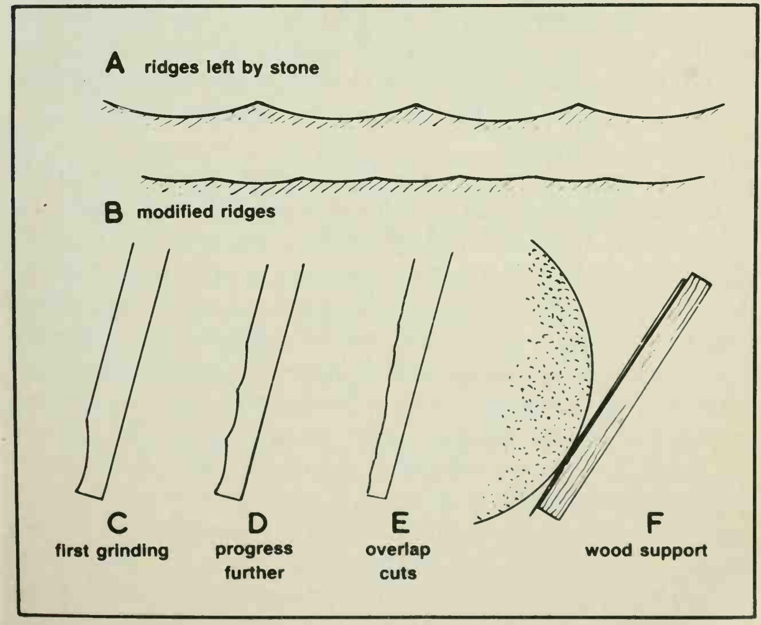


Fig. 6-8. Grinding across a stone makes a series of hollows as the section is shaped, then grinding lengthwise will smooth the surface.

hollows and ridges too deep and have to carry flattening them to a stage where you are making the blade hollow. It is wiser to aim at a slightly convex section until almost to size and take away the middle of the slope as a near-final step.

With a blade having part of the width from the back parallel and then a straight or hollow taper to the edge, the main problem is keeping the grinding below the intended dividing line. It may help to mark the line on both sides of the blade, although the final shaping will probably be by eye, with appearance being more important than strict compliance with a provisional line drawn on.

Start grinding by sweeping across near the edge. Thin that first and work back from it, with frequent inspections to see how the section is progressing. Work progressively from opposite sides. If the taper is to be flat, you can change to lengthwise grinding to remove ridges, but for hollow grinding you have to get the shape by crosswise grinding. With a wheel of large enough diameter the circumference may match the intended hollow and the final grinding can be in one sweep, but with a smaller wheel there has to be some careful manipulating to get a satisfactory hollow.

If there is a shoulder, grind close to its final position. If the edge of the grinding wheel is sharp, it can be taken close to the shoulder line. If not it may be better to use the clean edge of a new sanding belt to go into the angle. It would also be possible to file the last part of the shoulder angle. A neat break between the taper of the blade and the flat part of the shoulder enhances the appearance of a knife.

Many small grinders have their stones almost completely surrounded by guards, and it is difficult to grind anything lengthwise except a very small knife. Larger blades must have the crosswise ridges removed in other ways. It may be possible to work on the flat side of the stone. Alternatively, move to a belt or disc sander with a fairly coarse grit. It may not be possible to grind exactly lengthwise, but several diagonal sweeps will show the ridges and your progress in reducing them, or the curved cutting of a disc can be taken in several directions until the surfaces are flat.

All of this is on annealed steel. You have to decide how far to go before hardening and tempering. It would be unwise to take the blade right down to the final thickness and to a cutting edge at this stage. If it is too thin, heat-treatment may cause it to warp, twist or curl, and cracks may develop in the thin parts. A generally thick knife is unlikely to be affected in this way. If you harden and temper while the knife is thick and you are left with quite a lot of steel to grind off, this is much slower and more troublesome after tempering. Besides being harder and, therefore, slower to grind, you have to be on a constant watch against overheating, which can take out the temper. This means that after every stroke or two across the stone you have to dip the blade in water, thereby losing the more even control you get when you can continue grinding without interruption.

How much to leave for grinding after hardening and tempering depends on experience. If the final section is to be quite thin, you should not take off proportionately as much steel before hardening and tempering as you might with a blade that has quite a thick taper. For the average knife, you should leave about one-tenth of the grinding to be done after heat-treatment. For a generally thin knife it is better to leave about one-fifth. Dealing with one or two knives will show what is feasible, and you will adjust the amount of grinding accordingly.

POLISHING

Grindstone marks are fairly coarse, and if some part of the grinding has been done on a belt of disc, that will probably have been with a 40 grit or thereabouts. If everything so far has been done on the stone, using a 40 grit abrasive now will remove the scratches from the grinder. So far as possible, work across the grinding marks; then it is easy to see when they have been removed and replaced with the finer abrasive marks. You may find the coarse abrasive useful in finally shaping if there are still irregularities of outline or surface (Fig. 6-9). The back of the blade may be rounded, but be careful that the edges of the tang are kept square to the surfaces.

Follow 40 grit abrasive with 80 grit. Go all over the knife so that the new abrasive completely removes the scratches from the previous one. Changing direction will show when you have done this. This leaves a smooth surface, although it is not yet a polished one. It may be satisfactory to heat-treat at this stage, but you can continue to work on the surfaces with a 120 grit abrasive. The abrasive effect is quicker on annealed steel than on tempered steel, so it may be faster in overall time to do it now. Heat-treating steel with a very smooth surface is supposed to cause fewer internal stresses and less risk of warping or cracking. For much of the knife, however, you will be bringing surfaces to a high finish that will have to be ground later, and the abrasive stages will have to be repeated. A compromise is to bring those parts that are already

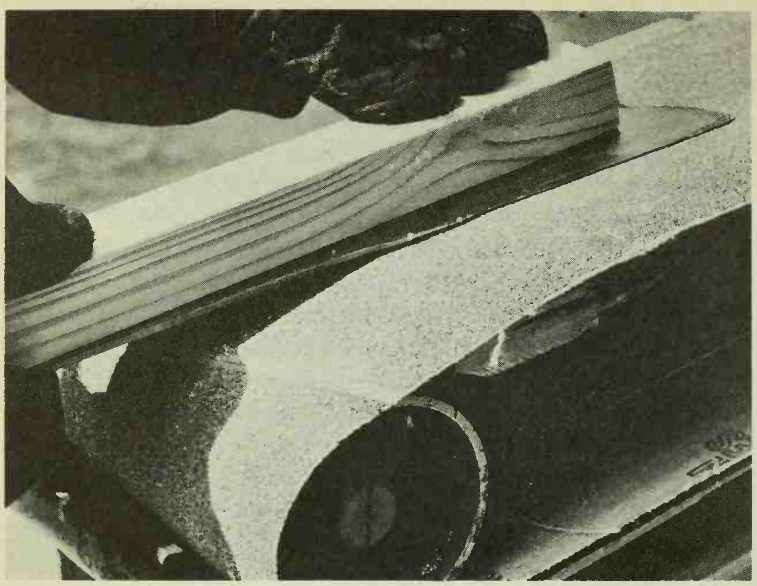


Fig. 6-9. When using a belt grinder on a thin blade it helps to apply pressure with a piece of wood.

to size to a high finish and leave those that will be ground at an 80 grit finish. The parallel part of a hollow-ground knife and the rounded back of any knife may be treated with 120 grit and the rest left with a coarser finish.

BLADE FINISHING

Hardening and tempering have been described in Chapter 2. The whole of the blade should be treated as far back as a short distance into the part that will be covered by the handle. Keep heating as even as possible. This reduces the risk of distortion. Thinner parts tend to get hotter than thicker parts. If you concentrate on heating the thick parts, sufficient heat should spread to the thin parts without directing the flame there.

Bring the blade to as bright a finish as possible after hardening and before tempering, but remember the steel is then quite brittle and could be snapped by careless handling. The tempering colors are more easily seen on a bright smooth surface than on an indifferent one. It is important to get as even a tempering throughout the blade as is possible. If an oven or kiln can be used, the exact control of temperature will achieve this, but if you have to depend on observing colored oxides, the thin edge can deepen in color very rapidly compared with the thicker back.

If the blade buckles during the heat treatment or if you take tempering too far, it is advisable to anneal the steel and start heat-treatment again. A buckled blade can be hammered flat after annealing. If it distorts a second time, you have made it too thin before hardening, and it may have to be discarded. If you tempered too far, it is not essential to anneal, and you can harden again and make another attempt at tempering. It would not do to merely retemper without rehardening as the finished steel would still be at the softer stage of the first tempering.

If hardening and tempering have been completed successfully, the blade must be ground close to the finished section. Have a supply of water nearby and dip the blade into it frequently. You should be wearing gloves, so you may not realize when the steel overheats, but it is better to cool too frequently than not enough. The thin edge, and particularly a fine pointed tip, are very likely to overheat from too-long contact with the grinding wheel. Keep the blade moving during grinding to minimize local overheating. Providing no oxides appear on the surface, you have not overheated. If the usual oxides appear at the tip or elsewhere, the temper has been drawn at that point, and the steel is soft in that locality, although it is still at the intended hardness elsewhere. If only a small part is affected, you may decide to continue as it is, but the only real cure is a return to hardening and tempering the whole blade again.

The moral is to prevent overheating by frequent cooling. Holding the knife back from the wheel so that it is in the airstream being pulled around by the wheel will cool it, but dipping in water is better. Bubbles of water that boil on the knife show how quickly the steel heats when it rubs on the grinding wheel.

Grinding should be taken close to the finished stage then followed by abrasive on belt or disc, working through 40, 80, and 120 grits to get a good finish. For a strictly utilitarian knife for outdoor use, this may be sufficient, but for the majority of knives it is better to get a polished finish. Buffing and polishing have been described in Chapter 4. Abrasive stages should have been done thoroughly if buffing is to be successful. If there are any abrasive marks from earlier stages that have not been obliterated by following stages, buffing will only show them up. Long work on the buffing wheel might eventually remove them, but this would be tedious. Buffing is a finishing stage, and metal removal is really something to do earlier.

HANDLES

For a full tang the handle is made from two slabs with glue between and rivets through. If many knives are being made it is convenient to have the handle wood in a long length already planed to width and thickness so that pieces can be cut off. Some knifemakers feel the handle looks better if the two slabs are made from one thickness of wood, then the grain markings on opposite sides are complementary. Stock for this type of handle should be double thickness, which may be prepared in a long piece. Then a suitable length can be cut to the outline and parted with a cut along the middle. This is convenient if the handle has a curved end or finger grip notches because the thick block can be cut to the outline. The two parts must match when they have been separated (Fig. 6-10A).

It is important that the surfaces of the slabs that come against the tang are absolutely flat. They could be held on a belt sander to smooth the surfaces, but because of its slight flexibility there is a tendency to round edges. It is better to level these surfaces with a plane. One or two strokes with a finely set smoothing plane will remove saw marks.

Position one slab under the tang and drill through then reverse the tang and drill the other slab. Do whatever shaping is needed to the end toward the blade. Other shaping can be done after the handle is assembled. There can be a straight or curved beveled end (Fig. 6-10B), or the end may be rounded (Fig. 6-10C). A sloping

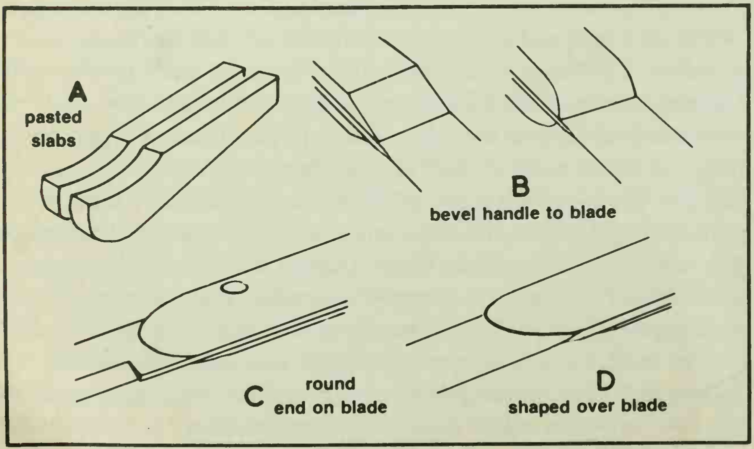


Fig. 6-10. Slabs and tangs may be shaped and there are several ways of shaping the slabs over the blade.

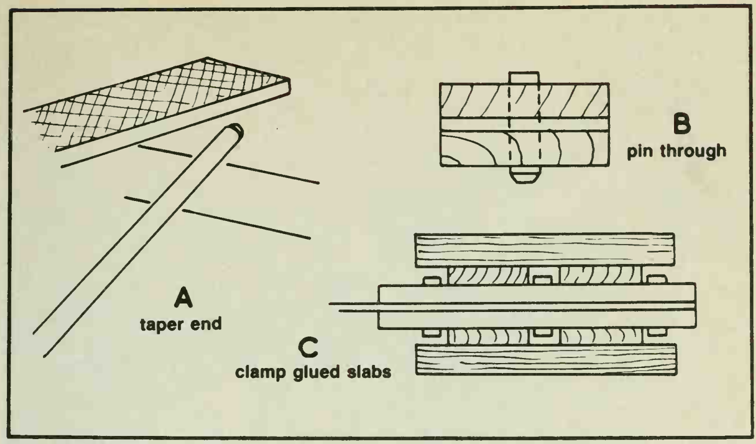


Fig. 6-11. Pins are tapered with a file for easy entry and the glued slabs clamped with packings.

end that goes a short distance onto the blade can be used (Fig. 6-10D).

The use of simple rivets was described for one of the end-sharpened knives in Chapter 5 (Fig. 5-4). These rivets can be used for any larger knives with slab handles, but there is often difficulty in finishing the hammered head to a true circle, and this marks the handle appearance.

There are several other ways of fixing the slab handles. The wood could be joined with epoxy glue and no rivets. Once this glue has set, it could be argued that rivets of any sort are unnecessary. Full-tang knives have traditionally been riveted, however, and a row of neat rivets certainly looks smart. Most people expect to see rivets, and an unriveted handle would look suspicious.

One way of giving the appearance of rivets without actually making heads on them is to use pieces of wire. These are really pins, not rivets. They could be $\frac{1}{8}$-inch to $\frac{3}{16}$-inch brass or copper wire. Holes are drilled to the wire size in the wood, although they could be oversize in the tang. Cut the wire or rod overlength. It is helpful to have a slight bevel on one end to ease entry into the hole. The simplest way to make this is to have a length of wire or rod in one hand, hold it over the edge of the bench and rotate while filing with the other hand (Fig. 6-11A). That pin is then cut off with a hacksaw while the rod is held in a vise, and the end is filed for a new pin.

Epoxy glue is put on the wood and the cleaned tang, and the pins are inserted. Let the pins project on each side (Fig. 6-11B).

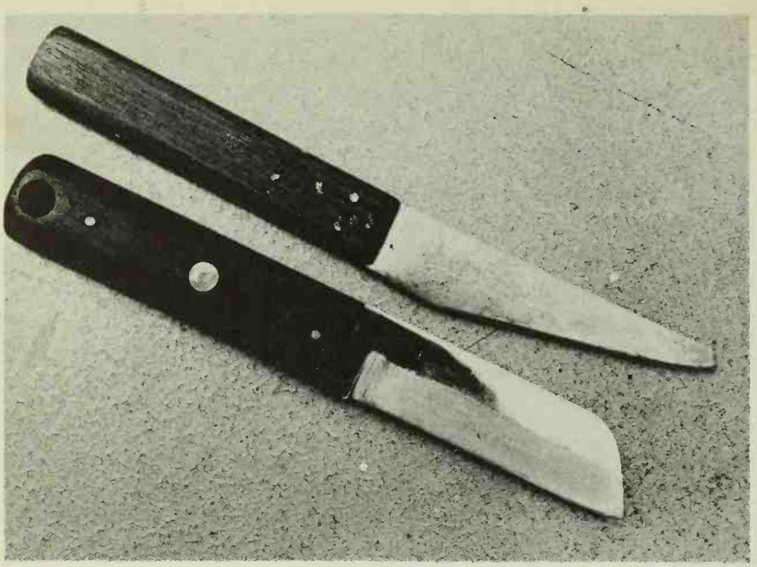


Fig. 6-12. The top half-tang handle has three pins. The other full-tang handle has two pins and a central rivet.

Put some pads of scrap wood between the pins and lightly clamp the handle until the glue has set (Fig. 6-11C). File the projecting pins level, before shaping the handle (Fig. 6-12).

The traditional way of fixing handles was with a special type of nut and bolt, called a *knifemaker's rivet*. These have long heads with screwdriver slots and are still available from specialist knifemaking suppliers, although they are much more expensive than rivets or pins. Holes are drilled through of a size to suit the screwed part (Fig. 6-13A). Both slabs are then drilled out with a

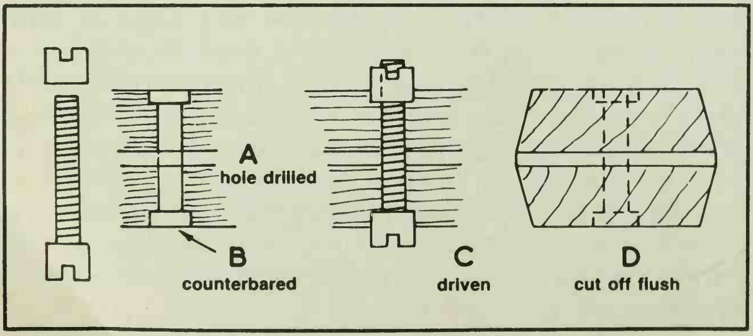


Fig. 6-13. Special screws may be obtained for fixing slabs. Their slotted ends are removed after fitting.

hole that is a close fit on the screw head and the nut, but these counterbores are not taken as deeply as the bottoms of the screwdriver slots (Fig. 6-13B). After assembling (Fig. 6-13C) as tightly as possible, the projecting ends are sawn, filed, or leveled with a belt sander to give the familiar plain circular appearance (Fig. 6-13D).

With strength coming from epoxy glue and less dependence on the strength of the rivets, two-part rivets may be used with prepared heads on each part to give true circular ends on the surface. One piece has a hollowed end, and the other piece has a solid end to drive into it (Fig. 6-14A). There can be glue introduced into the rivet to strengthen its fit, but most of the strength of the handle comes from the epoxy adhesive under the slabs.

Brass brake shoe rivets can be adapted to two-part use. There are several sizes, and your auto supply shop will have many of them. You should find that the end of one size will fit into the hole of another rivet two sizes larger (Fig. 6-14B). These can be paired to make knife handle rivets. Get the smaller size too long, so it can be trimmed to length. If its hollow end is cut off, that does not matter. The larger rivet should be long enough to go through the tang and into the other slab (Fig. 6-14C). The short rivet is cut off to a length that will go into the hollow end of the other piece but not touch its bottom when the heads are tight (Fig. 6-14D).

The heads of these rivets are countersunk, but to a flatter angle than woodscrews (Fig. 6-14E), so a normal countersink bit will make a hollow that does not match (Fig. 6-14F). This may not matter in hardwood, as the rivet will ear against the top of the countersink quite well, but it may be advisable to make a countersink bit with an angle to match the rivets. This could be a piece of steel rod hammered flat after heating to redness. Its end is ground parallel-sides and with a cutting angle to match the rivet head (Fig. 6-14G). The edges are backed off a few degrees to make cutting edges (Fig. 6-14H). Harden and temper to a brown color. As only a very slight countersinking is necessary, it is wise to use the bit in a hand brace. An electric drill on a stand could be used, with its stop set to prevent the bit from going too far. Freehand electric drill countersinking is not advised because cutting too much is likely.

Check when the two parts of a rivet are introduced to a hole that when one head is flush the other does not stand up by more than the depth of the hole in the hollow end; otherwise, the rivet will not close completely. The smaller end has to find the hole in

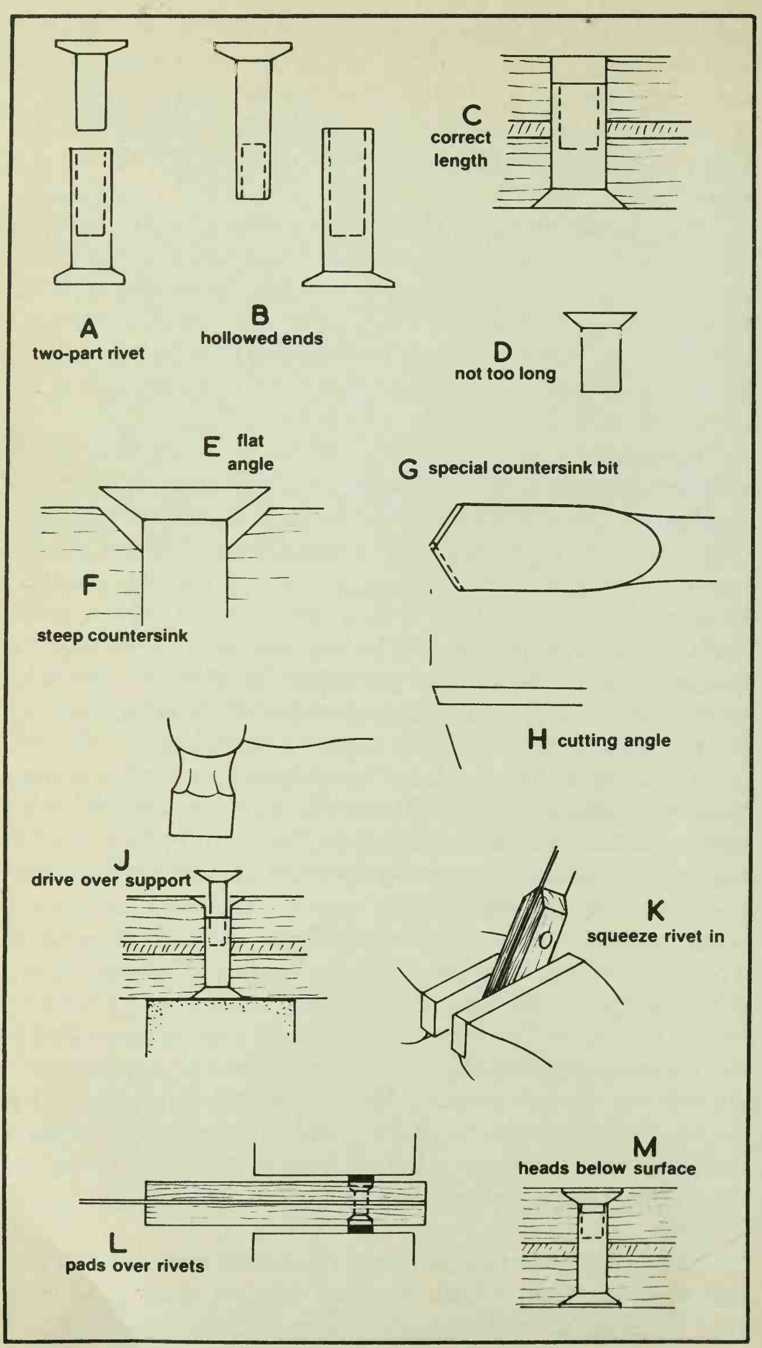


Fig. 6-14. Two-part rivets can be hammered or squeezed together.

the other piece. Bevel around it slightly after cutting to length so that it is easier to enter. Have a little epoxy glue around the rivet parts, then bring them together. While one head is supported on an iron block, the other can be tapped in with a hammer (Fig. 6-14J). It may be better to squeeze each rivet in a vise (Fig. 6-14K). This is more positive than hammering and less likely to cause rivets to go askew. To get maximum tightness, put a metal pad, such as a small washer, over each head. Then the final thrust is not limited by the fact that the vise jaws are squeezing against the wood slabs (Fig. 6-14L).

These rivets do not have very thick heads, so here is little tolerance for metal to be worn away when shaping the handle. It is better to allow for some wearing away of wood and a little of the rivet, so heads may be very slightly below the surface of the wood to allow for this (Fig. 6-14M).

A proper rivet with a spread head draws parts together, and this is important if slabs are being fitted without glue. There are broadheaded copper rivets with matching washers that were originally intended for making joints in machine belting (Fig. 6-15A). Copper is easily hammered to make a head and will polish to look attractive in a handle.

The washer should be countersunk so that the head made there will be flush. Counterbore the slabs so that the prepared head and the washer will come level with the surface, or just below it, to allow for shaping (Fig. 6-15B). The hole in the tang should only just clear the rivet, and the holes in the slabs may be that size or very slightly undersize so that the rivet has to be hammered through.

Drive the rivet through and fit the washer over its end. Cut off the point to leave a little more than will be required to fill the counter sunk washer (Fig. 6-15C). Support the head on an iron block and start spreading the end with light blows from a light hammer, with a cross or ball peen (Fig. 6-15D). Heavy blows would bend the copper, either above the washer or in the thickness of the wood. Fill the countersink and leave any excess standing (Fig. 6-15E) to be filed or ground off when the handle is shaped.

If prepared rivets of this type are unavailable, it is possible to use a piece of copper rod or wire and two countersunk washers (Fig. 6-15F). Support on an iron block, but work a little at a time from each side, so both heads are formed gradually. Hammering too much at only one side will result in one large head and one that will not fill the countersink.

With the slabs made from dense hardwood, it would be

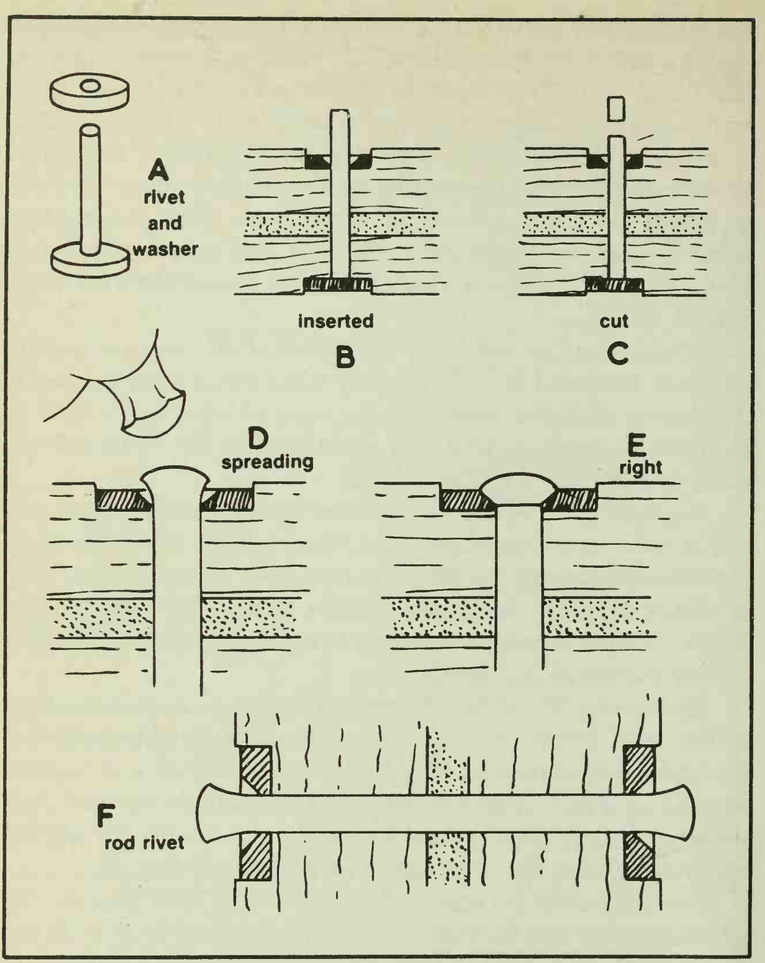


Fig. 6-15. Rivets through countersunk washers can be finished to a similar appearance on both sides.

satisfactory to rivet without washers, using soft copper or brass rod to supplement the epoxy glue. In that case, drill the slabs and the tang for rivets (Fig. 6-16). Countersink lightly for the rivet heads. Drive through all rods and file them until there is sufficient metal left to hammer into the countersunk holes. Support the handle on an iron block and form the heads progressively from opposite sides, using a ball peen hammer (Fig. 6-17), until you have filled the countersinks; then file the metal with the wood and sand both wood and metal.

When glue has set and the slabs are tightly bonded to the metal,

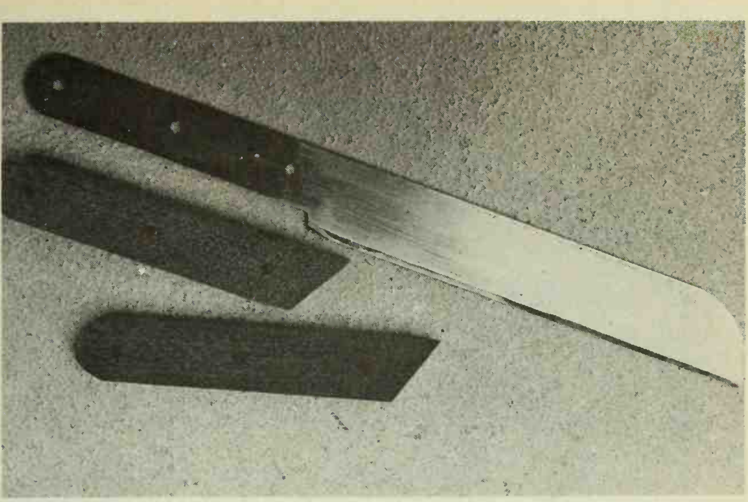


Fig. 6-16. The knife tang and slabs have been drilled for rivets.

handle shaping should be tackled systematically. Bring the outline of the wood to match the tang. Flats and outer curves can be worked on a belt sander (Fig. 6-18A). It is inadvisable to use the same belt for wood and metal because particles of metal in a used belt may

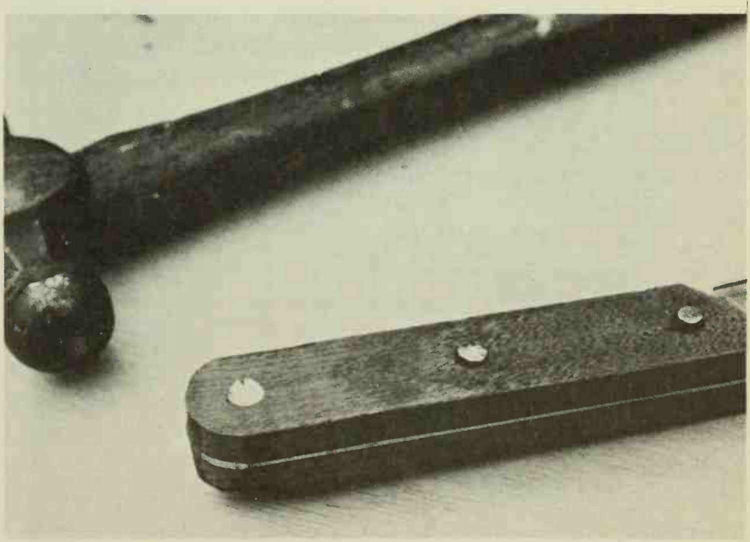


Fig. 6-17. Rivets at three stages—that at the right is ready for hammering, a head has begun to form on the middle one, and that on the left fills the countersink and is ready to be filed flush. All hammering is done while the handle is supported on an iron block, and work is done in stages from opposite sides.

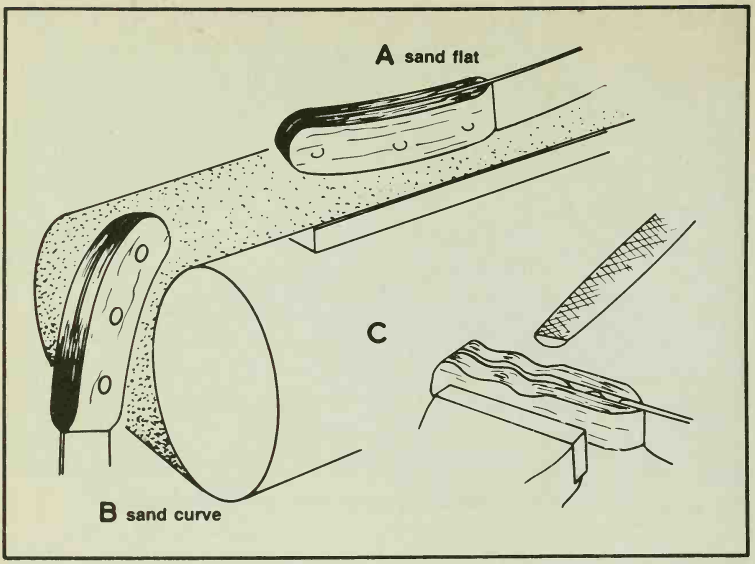


Fig. 6-18. Slabs may be sanded to shape, with hollows formed over a roller or by filing.

mark and discolor the wood. There will be some touching of metal by a belt used on wood, but if a new belt is put on the machine, contamination by metal particles will be minimal. Hollows may be worked where the belt goes over a roller or by an extending edge (Fig. 6-18B), but there will be some hollows where it is more expedient to use hand methods. A round or half-round file across finger notches will get them to the same shape as the tang edge (Fig. 6-18C).

When the outline of the slabs matches the tang, get their surfaces level, either on a belt sander or by rubbing flat on a sheet of abrasive paper. Take the surface down until you are just rubbing the rivet heads.

Decide on the degree of edge rounding required. Some butcher knife handles have the sharpness taken off the section, and there is no further shaping (Fig. 6-19A). Users claim this gives more control in the hand than the more comfortable fuller rounding. Another shape has a slight angle on each side of the tang with the outer edges rounded (Fig. 6-19B). This can be worked freehand by manipulating the handle against a belt sander. Be careful to keep the same angle all the way around. Hollows can be filed to match.

For some handles, such as bread and sandwich knives, it is better to make an elliptical cross-section (Fig. 6-19C). There are

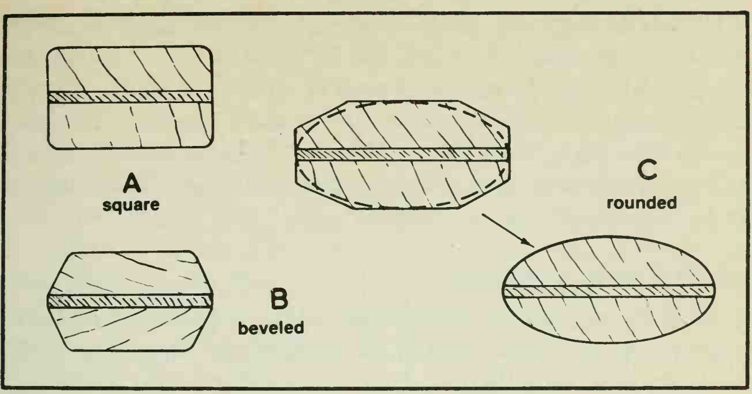


Fig. 6-19. Handle sections may be anything between square and elliptical.

several ways of working this. If the outline is straight or convex curved, the simplest way is to shape on a belt sander. Hollows may be worked with the extended edge of a belt sander, but they can also be filed or made with a half-round Surform tool.

Whatever the type of shaping the handle will finish with there will be scratch marks around it and across the grain. They must be removed by sanding with the grain. With some types of handle this could be done with a fine belt. A better finish is obtained, particularly on shaped handles, by hand sanding. Use a grit comparable with the last power belt used, until all cross-grain

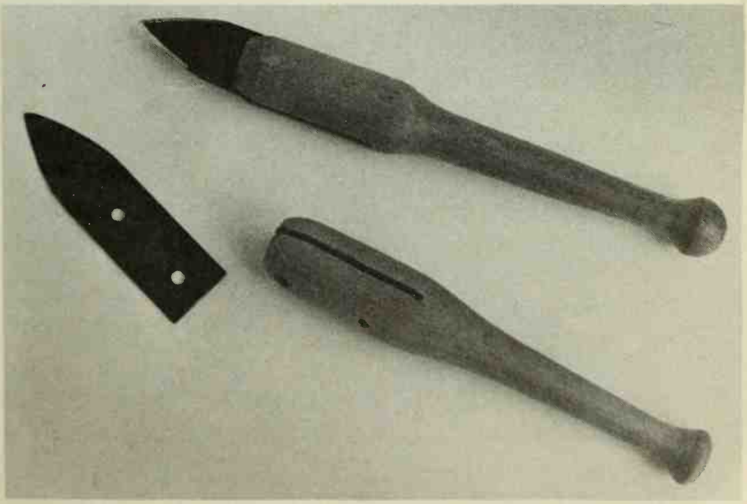


Fig. 6-20. These part-tang knives have turned handles. Each blade is held with epoxy glue and two pins.

scratches are removed. Then change to finer grits until the degree of smoothness wanted is obtained.

Finish the handle soon after sanding with oil or varnish. Lightly sanding between coats should produce an attractive smooth handle. Leave sharpening the edge until the handle is finished. If there is still visible thickness along the edge, thin it on a fine belt, but change to an oilstone for the final cutting edge.

PART-TANG HANDLES

Tangs that go right through the handles are common for many types of knives, but some light knives have part tangs (Fig. 6-20). In its simplest form the tang goes into a slot in a solid handle and is held by two rivets (Fig. 6-21A). This does not have the ability

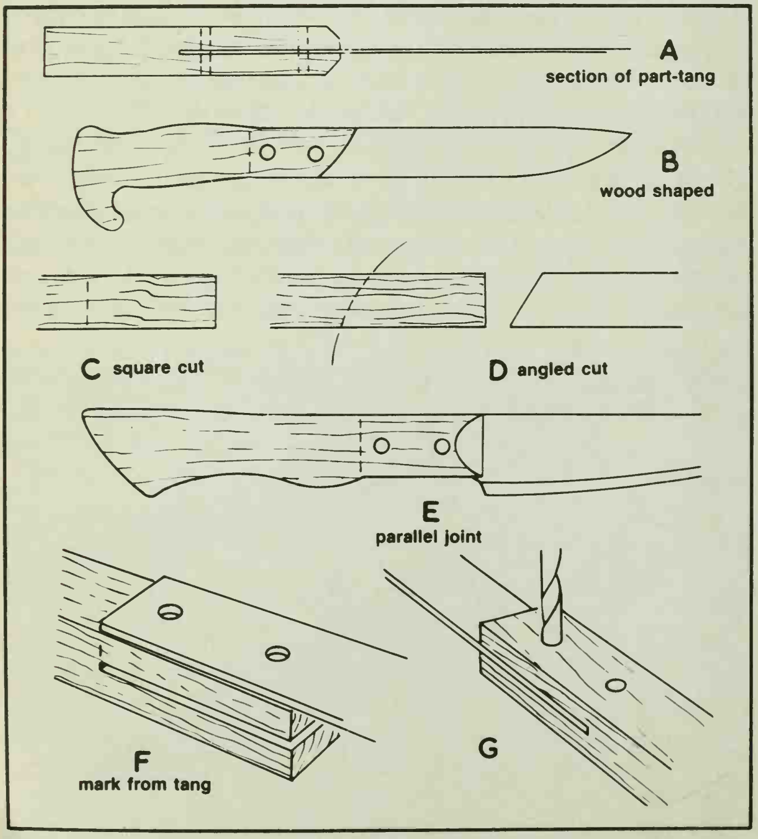


Fig. 6-21. A part tang permits more shaping of the handle. The tang may slope to suit the cut. Holes may be marked from a drilled tang or made through handle and tang in one action.

to withstand as heavy a pressure as a full-tang knife of the same size would, but for peeling fruit and similar light work there is ample strength. The method of construction also allows the end of the handle to be shaped without any limitations that would be imposed by the presence of a tang there (Fig. 6-21B), particularly when there is considerable curve that might involve waste and much work if a full tang had to match (Fig. 6-22).

Construction involves cutting a slot in the handle to match the tang. Normally the tang is cut square across (Fig. 6-21C), but it may be convenient to cut the slot with one or more passes of a circular saw, and the tang can be angled to suit the slot end left by the saw (Fig. 6-21D).

The farther the tang is taken into the handle, the more leverage its attachments have to resist pressures. It is usual to arrange the outline of the handle so that there is a parallel part, or one matching the tang, for about one-third of the length of the handle (Figs. 6-21E and 6-23).

If rivet holes are made in the tang first, it can be put against one side of the handle and the holes marked through, care being taken to see that the end of the tang is opposite the end of the slot (Fig. 6-21F). Another way is to make the handle to this stage before the blade is hardened and tempered; then clamp the two parts to-

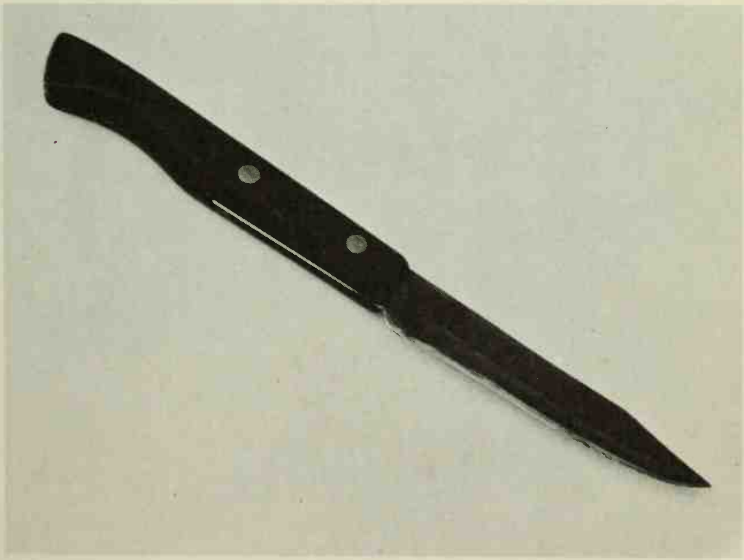


Fig. 6-22. With a part tang the handle can be shaped without the need to touch the tang.

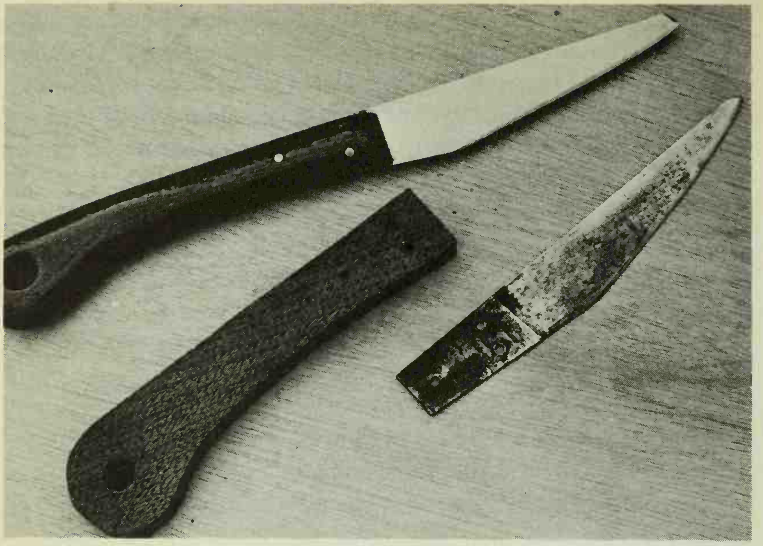


Fig. 6-23. A part-tang knife with three pins and another with its tang and the handle blank drilled, but not shaped.

gether and drill through wood and steel at one time (Fig. 6-21G). Further work on finishing the knife is the same as for the full-tang type.

Another way of attaching a blade to a solid handle that has a

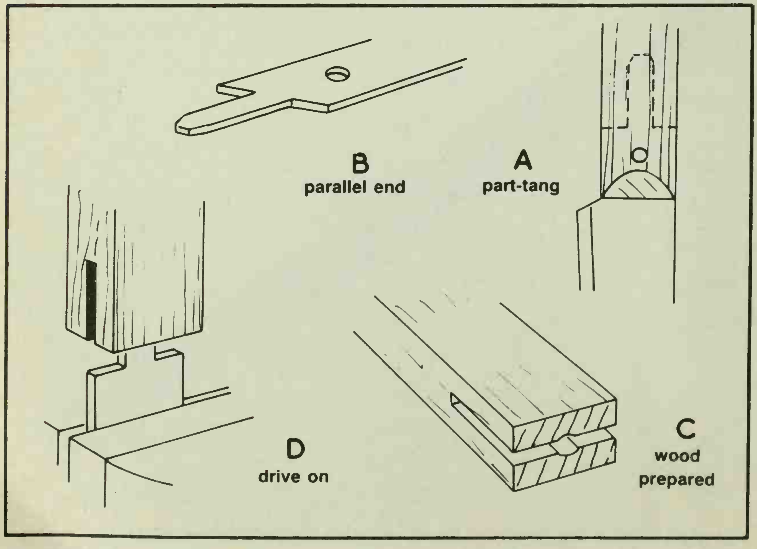


Fig. 6-24. A part tang may go into a hole with a slotted entrance for stiffness.

narrow parallel tang with a hole in it is to push the full width of the blade into the handle. Then attach using one rivet (Fig. 6-24A). This suits small knives but is not advised for anything that may receive heavy use.

The parallel tang is ground to about $\frac{1}{4}$ inch width and given a slight taper on the end (Fig. 6-24B). The handle is drilled undersize for this. In most woods it could be $\frac{3}{16}$ inch or less. Across the hole is a slot for the depth of the wider tang to go into (Fig. 6-24C). For greatest strength the parallel tang should not be test driven and then withdrawn. The single rivet hole should be made in the tang and used to mark the wood. Drilling wood and metal is not practical once the blade has been tempered.

A drive fit should be all that is needed, but there may be some epoxy adhesive introduced into the hole before the tang is driven. Have the knife in a vise with the tang upward and drive on the handle. Watch that the slot will match the wider tang when the handle has been driven that far (Fig. 6-24D). Fix the rivet and complete the handle in the ways already described.

If you are working with fairly thick steel, it is easier to grind a tang than to saw and file it (Fig. 6-25). The whole of a blade can be shaped by grinding, but if it is small, hold the steel with a hand vise or other secure holding device (Fig. 6-26). In the example, the

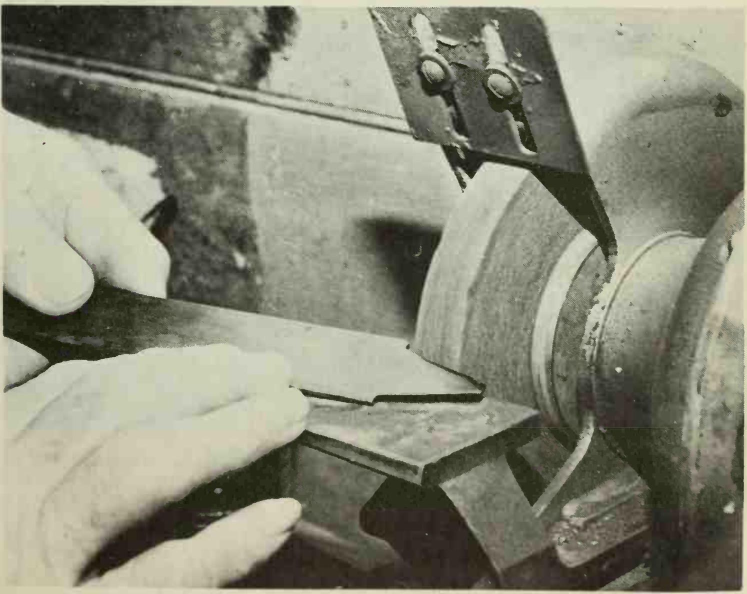


Fig. 6-25. A thick tang is more easily ground instead of filed to shape.

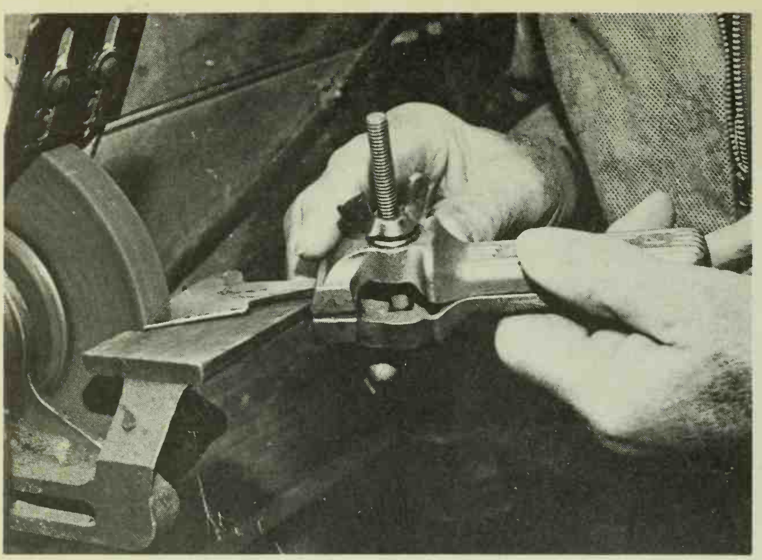


Fig. 6-26. A small blade should be held with a hand vise.

blade is set into a cut in the ferrule of the handle to make a leatherworker's knife (Fig. 6-27). If the hole for the tang is drilled in steps with drills of different sizes, the blade will be secure without a rivet through it.

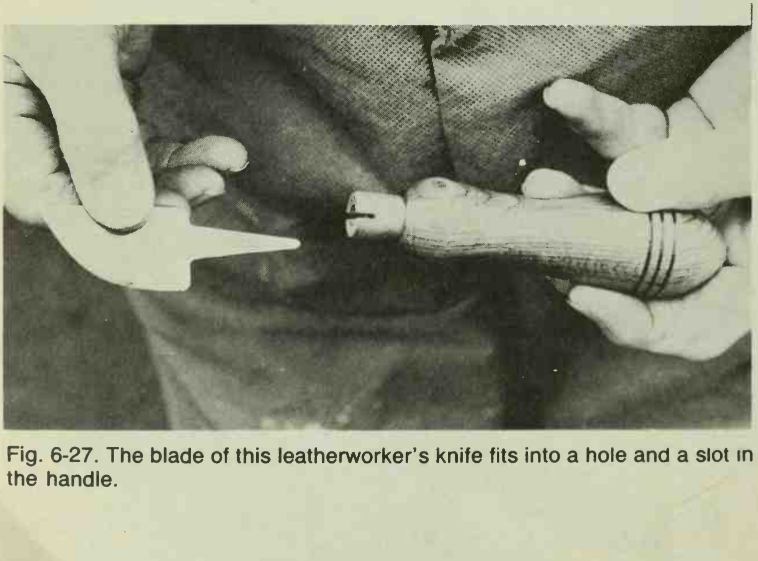
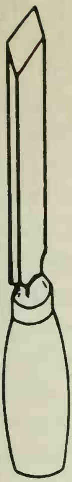
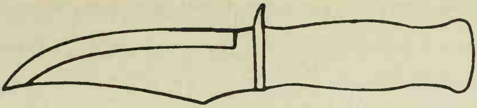


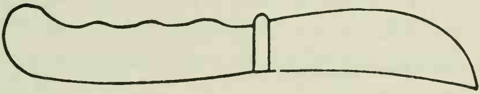
Fig. 6-27. The blade of this leatherworker's knife fits into a hole and a slot in the handle.





Chapter 7

Bolsters and Guards



Many knives need nothing between the blade and the handle. Much depends on the type of knife and its intended use. When a knife is intended for heavy work, there is an advantage in having a metal pad between the blade and the handle, as it provides strength at a point where there could be a risk of the steel breaking or bending. It also seals the handle from anything on the blade, such as moisture from food, from creeping between the handle parts and the tang. It can also be regarded as a design feature. A knife that has been worked to a pleasant shape has its overall appearance enhanced.

The metal pad is a bolster. In its simplest form, it is no larger than the end of the handle (Fig. 7-1A), then it may be called *butt plate.* A metal cap or knob at the other end of the handle may also be called a butt plate (Fig. 7-1B). For many purposes a bolster of the same width as the handle is all that is needed, particularly with a dropped edge knife, where the design keeps the fingers away from the sharp edge. In other knives it is advisable to continue the bolster to form a finger guard (Fig. 7-1C). This need only extend downward and may be produced by shaping the same metal as the bolster, or the guard may be a thinner plate without a bolster (Fig. 7-1D).

Swords and daggers needed guards all around to provide resistance for the hand during a thrust or to keep the hands away from a double edge. A guard extending both ways (Fig 7-1E) is still seen in the large Bowie knife, but this is more than tradition and

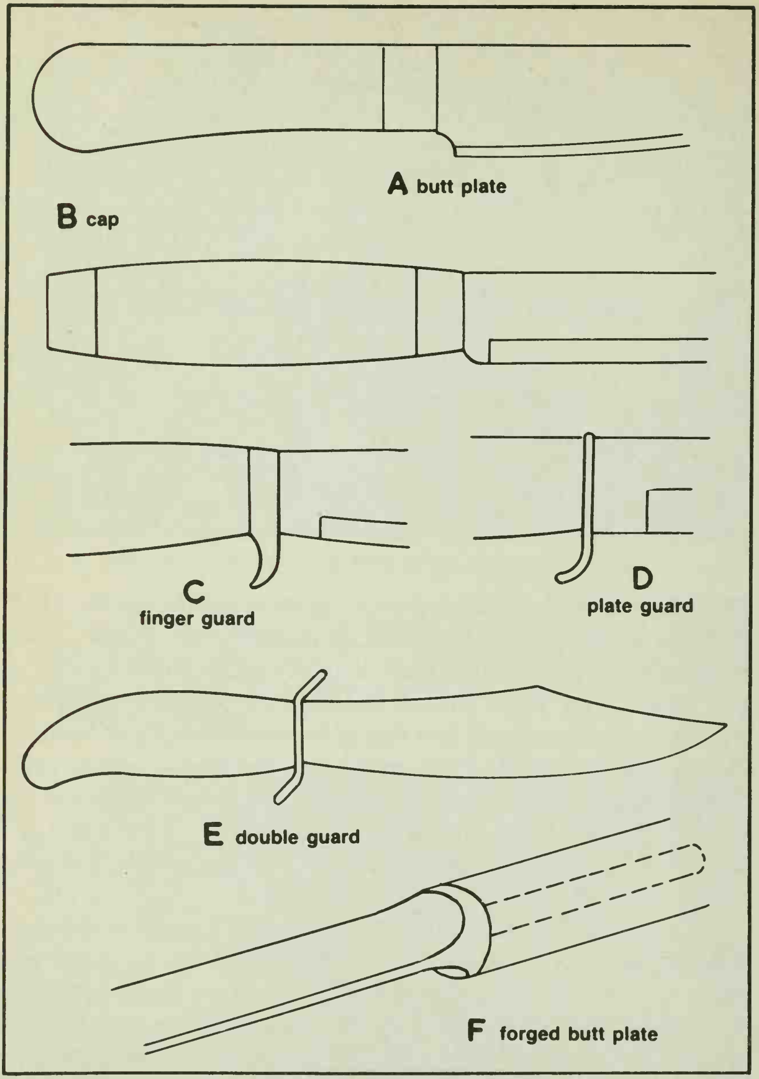


Fig. 7-1. Metal at a handle may be a butt plate or bolster. It can be extended to make a finger guard.

appearance than for a real need of the upper extension.

In some manufactured cutlery, there is a butt plate forged in the steel, usually followed by a round tang (Fig. 7-1F). This form is difficult or impossible for an individual with simple equipment to make, but it may be met when an old or broken table knife is being given a new life as a different sort of tool. In nearly all individually made knives anything between the handle and the blade is added as another piece of metal.

Although added bolsters or guards could be made of steel, it is more common to use another metal or alloy, mainly for the sake of appearance. The most common is brass (alloy of copper and zinc). Copper would be rather soft, but there are alloys of copper with other metals, such as tin, that give a more golden appearance than brass. Although there are aluminum alloys that might seem suitable, they present difficulties in bonding to the steel by brazing or soldering. There are prepared guards that can be bought. They are aluminum castings intended to be fixed without using these methods. Several other alloys, such as nickel, silver, and bronze, can be used. The parts of a bolster are small, and they may be made from scrap pieces from other projects that would otherwise be thrown away.

A simple finger guard can be slid over the tang, which is made narrower than the blade so that there are shoulders (Fig. 7-2A). If the guard is no more than about $\frac{1}{8}$ inch thick, the slot can be made by drilling overlapping holes (Fig. 7-2B). Then a thin file is entered to clean the slot to shape (Fig. 7-2C). A *warding file,* intended for cutting keys and lock wards, is suitable.

It might be sufficient to press the guard against the shoulders by fixing the handle close to it. It would help to use epoxy glue between the handle ends and the guard (Fig. 7-2D). It would be more satisfactory to braze or solder the guard in place (Figs. 7-3 and 7-4), however, as described later in this chapter.

A wider butt plate might be made in two pieces and held in place with two pins or rivets (Fig. 7-2E). The two parts could be partly shaped before fixing, but they would have to be finally fashioned and polished after fixing. If the meeting surfaces are flat and the rivets tight, this type of butt plate should be satisfactory. The rivets should be the same metal as the butt plate with the holes arranged so that the countersunk heads will not be filed or ground away in shaping. There must still be some of the countersinks left to provide a grip after rounding (Fig. 7-2F). This method of fixing could be supplemented by soldering.

To get a close fit with a riveted butt plate, hold the parts together with a hand vise or grips while tightening one rivet. When the rivet is tight, remove the vise and deal with the other rivet. Let the rivets be long enough to more than fill the countersinks (Fig. 7-2G). Rivet on an iron block, working a little from each side and frequently turning the work over so that each head progresses

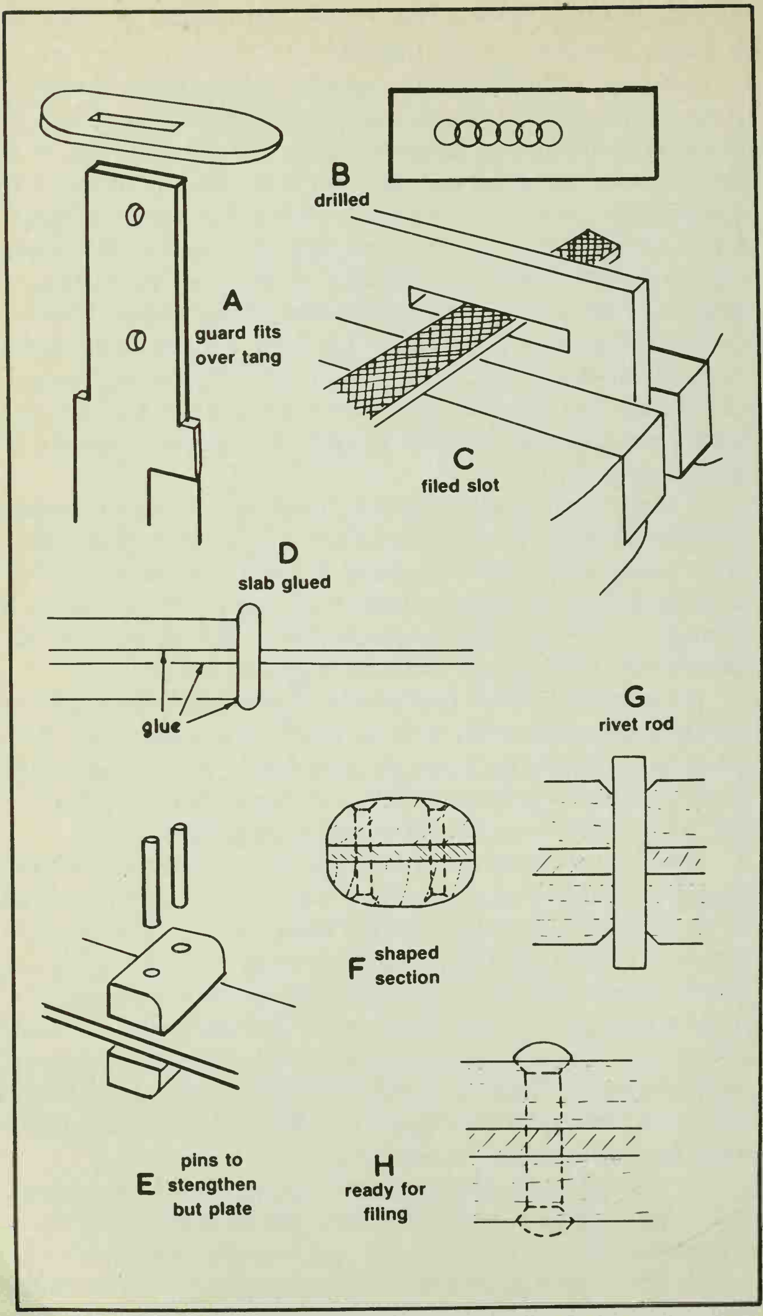


Fig. 7-2. A finger guard can be slotted over a reduced tang and the handle slabs brought close to it. One type of bolster is riveted in place.

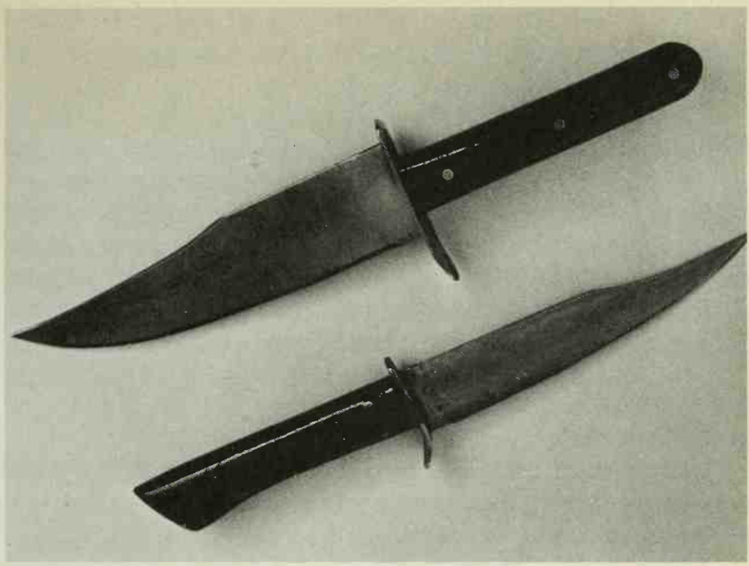


Fig. 7-3. Two hunting knives with guards soldered on.

by about the same amount, until the countersinks are full and there is surplus to be filed or ground level (Fig. 7-2H).

A riveted butt plate might be extended to make a small finger guard, and a butt plate at the end of the handle could be curved down to make a shaped knob, but rivets only could not be expected to withstand the extra leverage due to too much of an extension. It would be better to braze or solder.

FUSED BOLSTERS

Attaching a bolster, which may be extended into a finger guard by brazing or soldering, makes it more solid with the steel of the blade. The joint should be stronger than any mechanical attachment with rivets or a guard slotted and augmented with epoxy glue. These methods of flowing molten metal into the joint with the aid of a flux produce a metallic fused bond between the parts.

The basic methods of soft soldering, silver soldering, and brazing were outlined in Chapter 3. Here we look at their application to the particular jobs of attaching bolsters and finger guards. The amount of heat required must be considered in relation to hardening and tempering of the blade. Soft solder (lead and tin alloy) melts at a temperature lower than tempering temperature, so it is possible to complete the heat-treatment of a blade and then work it to a nearly finished state by successively finer abrasives, before soldering because the heat used will not be enough to draw the temper of the blade.

Hard or silver solder is a copper and zinc alloy, similar to spelter, but one or more other metals are included to lower the melting point. Silver is commonly used—hence the second name—but some other metals have similar effects, and the types of hard solder are often described by their melting temperatures. If the melting point is below the tempering point of steel for knives (about 500° F.), it is possible to hard solder a bolster to a blade that has been hardened and tempered without drawing the temper. Melting temperatures are not a long way below this, but if the hard solder is intended to melt at 450° F. or lower, the joint can be made by carefully heating a fully heat-treated blade. Otherwise, it is advisable to attach the bolster before hardening and tempering. The completed joint will stand heating until the steel begins to glow red, which is sufficient for hardening.

Spelter used for brazing (copper and zinc alloy) needs the parts raised to red heat, so steel that has been hardened and tempered would have the temper drawn in the process. This means that a brazed bolster has to be fitted before the heat-treatment of the blade. A further problem is in the choice of a bolster alloy. Spelter is a form of brass. It is alloyed to give the lowest possible melting point, but this may not be much below the melting point of some brasses used for bolsters, so slight overheating could mean the loss of the bolster by melting. This may also happen during hardening of the steel, when raising the temperature too high near the bolster might loosen the brazed joint or, if carried too far, melt the bolster. Those are the snags. Many bolsters are brazed successfully, but anyone making only a few knives is less likely to meet trouble if brazing is avoided—at least until experience has been gained with the other methods.

Joints should be mechanically clean. This means scraping or rubbing with abrasive just before making a joint and then avoiding fingering the surfaces, as this will deposit a film of grease. Wiping with acetone will remove grease. Heating causes oxidization, and the spelter or solder will not bond with oxidized surfaces. A flux is used for two reasons: it flows over the surfaces and prevents oxidization and encourages the solder to flow.

It is important to remember that whatever the method used, the metal of all parts of the joint have to be raised to the melting point of the solder being used. Solder might be melted by playing the flame directly on it, but it would stay in a molten ball if the surrounding metal was not hot enough. This means that heating has to be carried out first in a general way, playing the flame around and over the parts. There will be some heat loss to the parts away from the joint, but the metal in the vicinity of the joint has to be brought evenly up to the required temperature.

It is also important to remember that solder will flow toward the hotter parts. This means that after general heating to near the melting temperature, further heating should be done on the side of the joint opposite to where the solder is placed or applied. As the temperature continues to rise, the solder will begin to melt and come through the joint, where its presence will be seen by a silvery line.

SOFT-SOLDERED JOINTS

Soft solder of the type known as *tinman's solder* may be used. Although it is possible to make a suitable flux—zinc chloride is one—it is better to buy a paste or liquid one. Apply to cold metal with a brush, but afterward add any to hot metal with a piece of wire. Electrician's solder with a flux core is unsuitable. Neither the solder nor the flux will work satisfactorily on these bigger joints, although they are ideal for small wire joints.

Soft solder should be used only to supplement mechanical fastenings. A riveted bolster can be soft soldered, and it might be used for a guard slid into place over the tang. Put the knife tank upward in a vise, with the guard high enough to give room to work (Fig. 7-4A). Grip the blade between pieces of wood (Fig. 7-4B). Besides protecting the blade, they prevent heat from being lost into the metal of the vise. Put some flux on the meeting surfaces and some more on top of the guard. It is very easy to apply too much solder, so there is an excess to be cleaned off later. It is wiser to hammer the end of a stick of solder quite thin, then cut little pieces from it with tinsnips. Put what you judge to be enough solder for the joint on the guard (Fig. 7-4C).

Use quite a small flame from a propane or oxyacetylene torch. Work it around the joint (Fig. 7-5), above and below for general heating, then concentrate on the underside of the guard, but move the flame around evenly. If the flux appears to have boiled away, apply a few drops more closely into the joint. Do this if you see the solder melt into globules and not flow. The solder may melt quite suddenly. When you have seen it run into the joint, withdraw the flame immediately. Do not disturb the joint. The solder does

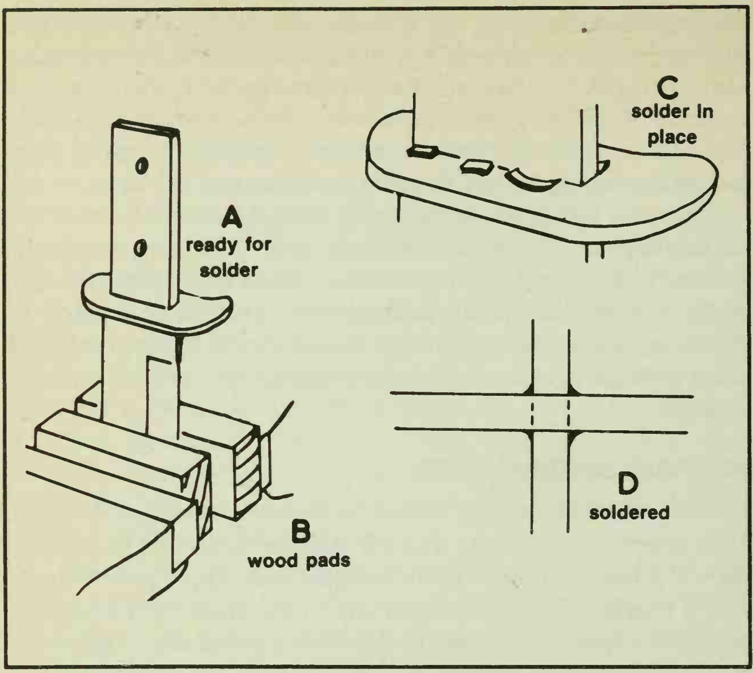


Fig. 7-4. Solder can be drawn through a joint by placing pieces on one side and heating the other.

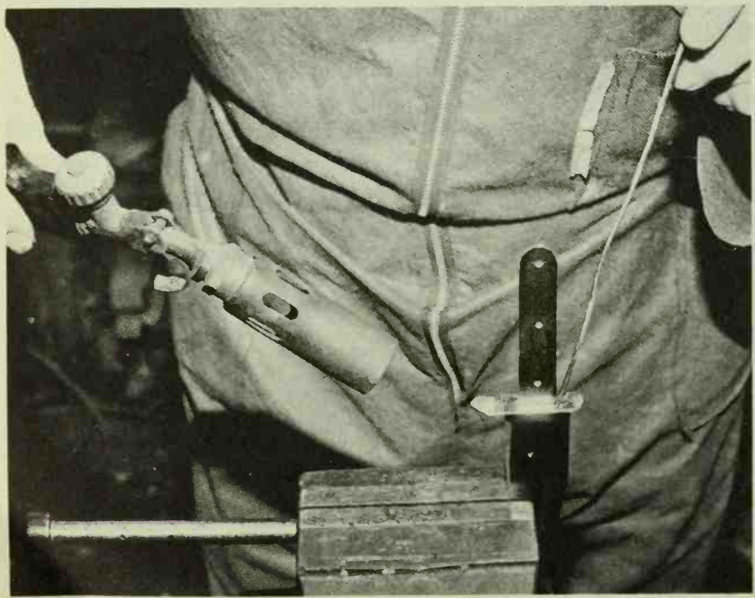


Fig. 7-5. Feeding solder onto the joint while it is being heated with a torch flame.

not take long to harden, but if the joint is moved as the solder is in a semiliquid state, the strength of the joint will be impaired. Molten solder has a bright silvery appearance. You may see it go suddenly dull. That indicates it has set, although it is still quite hot. It is probably best to leave the knife to cool enough to handle, but if you are in a hurry, it can be dipped in water after the solder has dulled.

Any excess solder can be scraped away, using a triangular scraper or a knife blade. If there is so much that you have to file it, use a coarse file because solder soon clogs a fine one. Abrasive will also remove solder, so you can use the edge of a belt sander or a piece of folded abrasive paper in your hand. It is wise not to aim at a sharp angle in the joint, but to leave a small fillet of solder on each side, however (Fig. 7-4D). Handle slabs can be be rounded slightly where they come against this.

A riveted butt plate could be soldered in a similar way. Soft solder will pass through quite a narrow gap, but riveting should not be continued to such a tightness as might be done if the joint was not to be soldered. Clean the surfaces of grease and rub them with abrasive just before riveting; solder fairly soon after. A few hours will not matter, but do not leave the riveted joint several days before soldering.

Polishing parts that have been soft-soldered may be done safely, providing the work is moved about. A buffing wheel or sanding belt kept pressing hard over the solder might generate enough heat to melt it, but moving the work about a relaxing pressure occasionally should keep the heat in the metal well below the melting point of solder.

HARD-SOLDERED JOINTS

Hard or silver solder flows best with slightly more of a gap than soft solder, but parts must still be quite close. It is not suitable for gap-filling or building up, so all parts should meet. It will run through if an attempt is made to fill a large space. This means that a finger guard built up with a part on each side of the blade cannot just be put on in anticipation that the solder can be used to fill the extended part (Fig. 7-6A). Instead, one piece may be grooved (Fig. 7-6B) or half taken out of each piece (Fig. 7-6C). There is no need to rivet or fasten in any other way. Hard solder will make a strong bond between the guard and the blade.

The flux used is borax, which may be a powder or bought as a prepared liquid. Powder can be put directly on the metal or mixed with water into a paste and brushed on. As the water boils it may lift off the borax and any pieces of solder placed in position. Prepared fluxes are not as troublesome. In any case, make a spatula to use as a small spoon to put on more flux or to push the flux that is there back into place as its water boils away or the powder bubbles as it liquefies. The spatula is a piece of iron wire about $\frac{1}{8}$ inch thick. Flatten its end by hammering on the anvil or an iron block. Point the other end so that it can be pushed into a handle or bend it into a loop (Fig. 7-6D).

Hard solder comes in wire or sheet form. Cut it into small pieces to put on the joint (Fig. 7-6E). Have a small strip ready to grip with pliers and touch on the joint if more is needed. The solder is attracted to a narrow gap as it melts, and quite a small amount will fill a joint. Using too much will cause troublesome hard lumps that have to be cleaned off.

The bolster parts have to be held in position, but this has to be done in a way that allows the flame to be used all around. The metal will be brought to quite a high temperature, and this will apply to whatever is used to hold the work, so if grips or a hand vise are used, care is needed not to overheat them so that they are softened. Another problem is the way a large mass of metal in the holding device will constantly dissipate the heat. This means heat

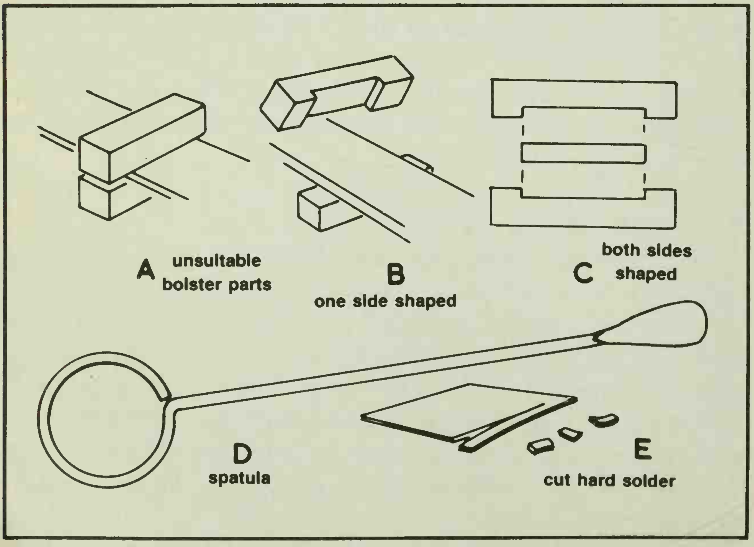


Fig. 7-6. A bolster can be made with parts to fit over the tang. Hard solder or spelter is cut into small pieces. These and the flux can be applied with a wire spatula.

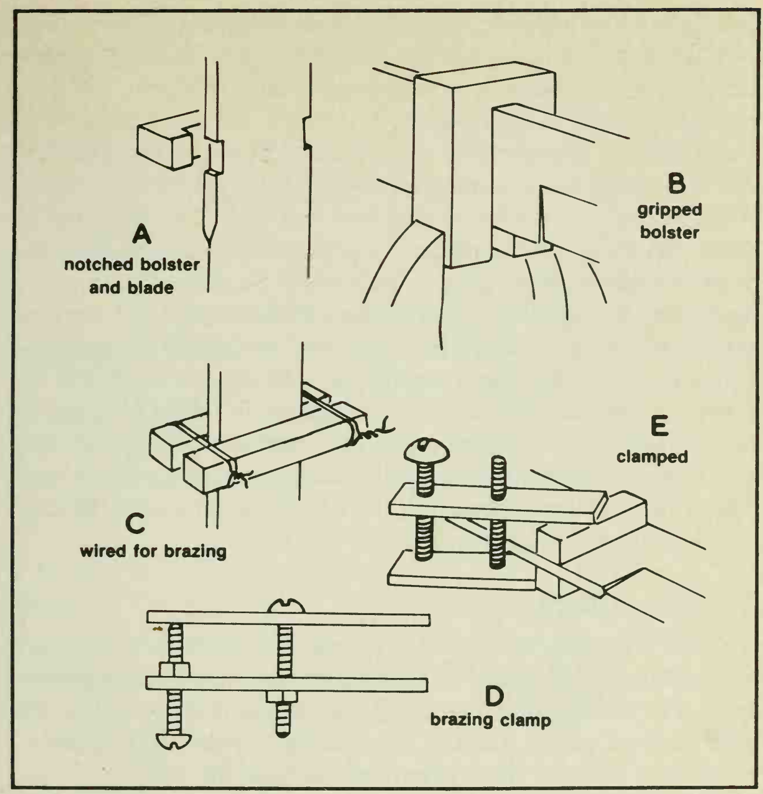


Fig. 7-7. Notching the tang locates the bolster. Parts can be wired or held with a simple clamp.

has to be applied to the joint longer than might otherwise be needed, and there is a risk of overheating one part to make up for the loss of heat immediately at the point being gripped. Using grips or a small hand vise is often the best way of securing the parts being worked on.

There are ways of helping the parts to stay exactly where you want them. If the sides of the bolster are cut around the blade, small locating notches can be made (Fig. 7-7A). Even when the bolster is to finish level with the blade edges, it may be made in one wider single piece with a cut to slip over the blade. Grips pulling the open sides together will give a secure hold (Fig. 7-7B). The extensions are cut off after the joint has been made.

Thin iron wire can be used to tie the parts in position. This has a higher melting point than the hard solder or the bolster parts, so although it will glow red, it continues to hold. Extensions of the bolster are tied with wire having its ends twisted with pliers (Fig. 7-7C). If the extensions are not part of the final bolster, they are sawn off before filing or grinding the bolster to shape.

It is possible to improvise small clamps that do not take up as much space as grips or hand vises so less heat is lost through them, and it is easier to get around all parts of the joint with the flame. Also, it does not matter if they are overheated, as they can be discarded and replaced easily. Two strips of mild steel form the jaws—a section about $\frac{3}{8}$ by $\frac{1}{8}$-inch would do, and a length of 1 $\frac{1}{2}$ inches would suit the average bolster. With them go two machine screws and nuts. Arrange the screw and nut nearer the gripping end so that they pull the parts together. At the other end, put the screw through one piece and bearing against the other with the nut on the inside, so it can force that end apart to make the jaw and grip (Fig. 7-7D). One of these little clamps arranged with its jaws centrally should be enough (Fig. 7-7E), although two may be used on the ends of a long guard.

BRAZED JOINTS

The technique of making a brazed joint with spelter is very similar to hard soldering. The main difference is the need for greater heat. The same flux is used, and the spelter may be laid on the joint in small pieces, but the whole assembly has to be raised to a red heat to make the spelter flow through the joint.

The knife can be held upright by its blade in a vise, but the bolster should be well above the vise level, so that the vise jaws do not suffer from the greater heat (Fig. 7-8A). Working in this way causes some heat loss into the air, so the flame has to be used longer and has to be moved around the work constantly to get the even heating required for the best spelter flow. This is not difficult, and many bolsters are fixed in this way, but if heat can be conserved, the time taken to make a good joint is reduced, and even heating is more easily obtained. This is done by supporting the knife in coke or asbestos blocks.

A blacksmith's forge is ideal for supporting the knife in coke; otherwise, something can be improvised with an iron pan and a sheet metal back (Fig. 7-8B). Coke or asbestos pieces are piled up around the knife, with the part to be brazed only a short distance above the surface. More coke is put around the back to reflect heat forward (Fig. 7-8C). The same assembly also makes a good forge or brazing hearth for other work, such as forging the ends of screwdrivers or drawing down the ends of pointed tools, when the

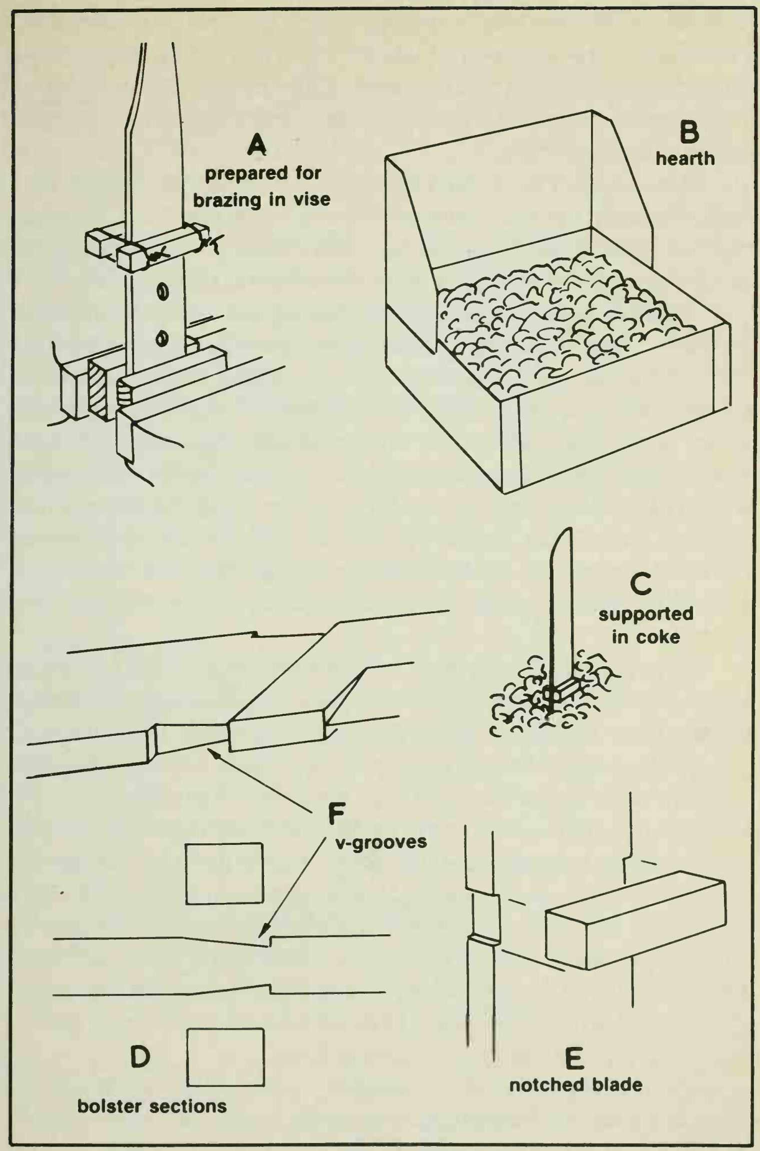


Fig. 7-8. Brazing can be done in a vise or on a hearth. Notching the tang helps the spelter flow into the joint.

more even and reflected heat from a torch will be quicker than heating with the same flame in air.

Spelter does not flow as thinly as hard or soft solder. It is possible to draw it through a narrow gap, but it has more tendency to build up. When a bolster or guard is to be fixed, the neatest result comes from getting the spelter melted in the form of fillets around the blade side and the ends of the bolster pieces, with no spelter on the tang side, so the joint there has a clean angle to come against the handle slabs.

This is achieved by having spaces for the spelter to fill. In a typical bolster, the parts from which it is made may start as pieces of brass about $\frac{1}{4}$ inch square (Fig. 7-8D). Shallow notches are made in opposite sides of the blade where these are to come. As the work is being done before hardening and tempering, the slots are made by filing. They should be slightly wider than the tang pieces (Fig. 7-8E). When the joint is made, these slots will be filled with spelter. On the blade side of the joint, make a small V-groove at each side of the steel (Fig. 7-8F). The bolster pieces will overhang these grooves with their edges almost level, and the grooves will be filled with spelter. Some spelter may flow farther under the flat meeting surfaces, but all the visible edges of the bolster will show where the steel, brass, and spelter have fused together, but at the side against the handle slabs, there will probably not be a spelter line showing.

Make sure all the meeting surfaces are mechanically clean by rubbing with fine abrasive and wiping with acetone just before putting them together. Clamp the parts in position. With practice, it is possible to do the brazing in one continuous action, but at first it is advisable to treat it as a three-stage operation. However, get flux on all parts to prevent oxidization, although you may only be concentrating on brazing at one point. This is done by holding the knife with tongs or grips so that heat can be applied sufficiently to melt the flux while the knife is being manipulated so that gravity will help the melting flux run into the joints (Fig. 7-9A). Not much heat is needed to do this, but it ensures at least some flux adhering all around. More flux will have to be added later as you melt spelter into each part of the joint to help it flow.

The first parts brazed are the side notches. If the work is being done in a vise, hold the clamp or grips in the vise so that the notch to be filled is uppermost (Fig. 7-9B). If the work is being done on a hearth, lay the assembly in the coke with just the part to be worked on projecting (Fig. 7-9C). A small piece of spelter can be put in the notch with flux, or you can apply flux only and have a length of spelter wire ready to touch the hot metal. Spelter wire about $\frac{1}{8}$ inch diameter is convenient and should be in a length sufficient for holding without the need for pliers or other grips as

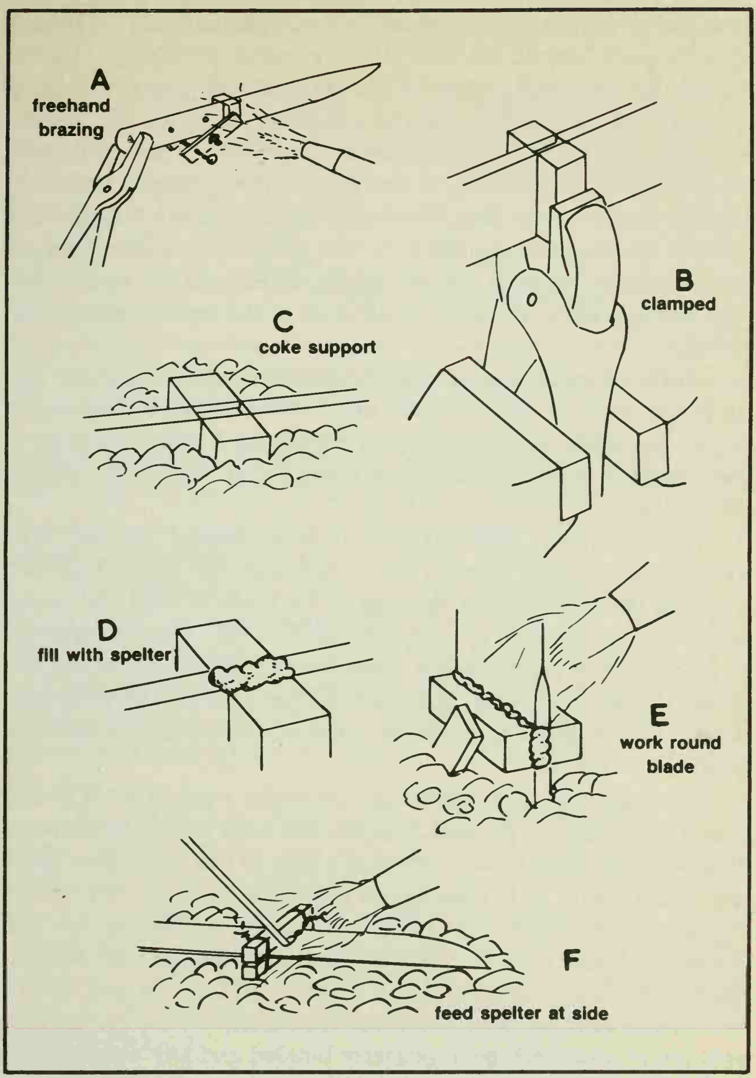


Fig. 7-9. All of the metal around the joint has to be raised to the melting point of spelter. Heat can be conserved by surrounding with coke.

protection against heat. Every time the spelter wire is used, dip its hot end in flux.

Heat around the bolster until it begins to glow red. This is sufficient to make most spelter flow. If a piece of spelter is already in the joint, this can be observed to melt, but more will have to be added from the end of the wire. When you touch it with the wire and feel or see it melt, withdraw the wire immediately. It is easy to let too much melt and flow where you do not want it. You will have to file and grind it off later. Do not heat more than is necessary to make the spelter flow. If you are using brass for the bolster, excessive heat will melt that as well. Most other alloys will stand up better to overheating. If you heat only enough to make the spelter flow, you will find it becomes pasty rather than liquid like solder. By manipulating the wire, the pasty semimolten metal on its end can be brought across existing layers and the notch filled and built up above the level of the ends of the bolster pieces (Fig. 7-9D).

Turn the knife over so that the opposite notch is upward and do the same there. Some spelter may be carried down the grooves across the knife, but this does not matter, as it will contribute to the fusing of spelter you will be doing there. Add more flux as necessary.

Finally support the knife with its point upward. Arrange it so you can get at both sides. This is easy with the clamp held in a vise. On the hearth, have an edge of the blade toward you so the flame can be brought to both sides (Fig. 7-9E). Heat around the bolster and melt spelter into the grooves at both sides. Practice will show how much to apply, but aim to fill the grooves and leave only a little on the surfaces to file or grind to a small radius between bolster and blade.

Brazing more than soldering may make a joint that is lumpy and possibly with air pockets. Practice will show how to avoid these. Heat must be taken to the bottom of a joint so that the spelter flows and fuses there. It is possible to get surfaces up to the spelter melting temperature, yet deeper into the metal the temperature is not quite high enough. Continue heating after the first signs of spelter melting. Move the flame about. It will not be long before the surface heat has penetrated into the metal, and the spelter that gets lower down will have properly bonded and any air gaps will be filled.

With the knife on a coke hearth the joints can also be made with the blade surface horizontal and one side dealt with at a time. Or you can start with the knife upright then use tongs to move it horizontal for convenience in finishing the line of joint across each side (Fig. 7-9F).

If there are to be pieces across the end of the handle so that the handle slabs are between butt plates and a bolster or guard (Fig. 7-10A), they can be brazed in the same way. Notch each side and

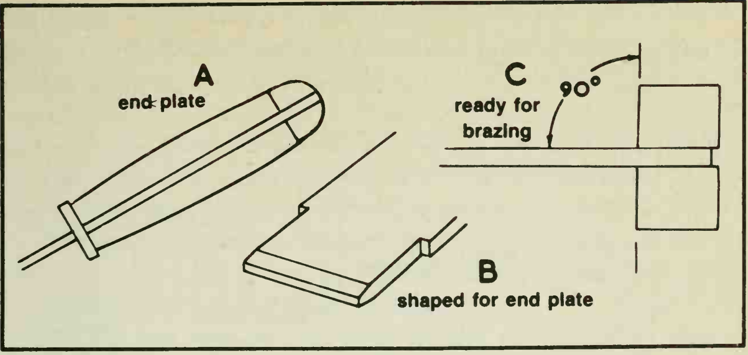


Fig. 7-10. An end butt plate is cut to fit squarely against the handle slabs and cut oversize for later shaping.

slightly bevel the end of the tang to accept spelter (Fig. 7-10B). The metal for the butt plates may be slightly oversize in both directions, for trimming later, but the sides toward the handle should be carefully arranged level (Fig. 7-10C).

When brazing is completed, do not dip the knife in water to cool it. This may leave parts of it hard and parts soft. There could also be distortion due to the uneven heat. It is better to let the knife cool quite slowly so that the steel is annealed or normalized. Cooling will be quicker in air, but not so quick as to matter, and a knife brazed on a coke hearth will benefit from being left to cool with the coke.

After brazing, all of the knife, including the bolster, will be black, and surplus flux will have left a glasslike film around the joint. If the steel had previously been sanded to a good surface, this will be quickly restored by using the same sanding belt or disc, except where there is flux. The glazed flux can be chipped away. Light taps with the end of a screwdriver or pointed tool will break it off. Once the glaze has been chipped, it will sand away as the metal is cleaned.

SHAPING A BOLSTER

How the bolster is dealt with depends on its intended design. There could have been some preliminary shaping before brazing, but in most cases it is better to get a solid squared bolster in place and shape it in position. With a simple bolster without overhang or finger guard, the pieces are fixed so that they overhang slightly. The first step after brazing is to level the edges (Fig. 7-11A). As the metal is soft, it is easily filed, or it can be ground away on a

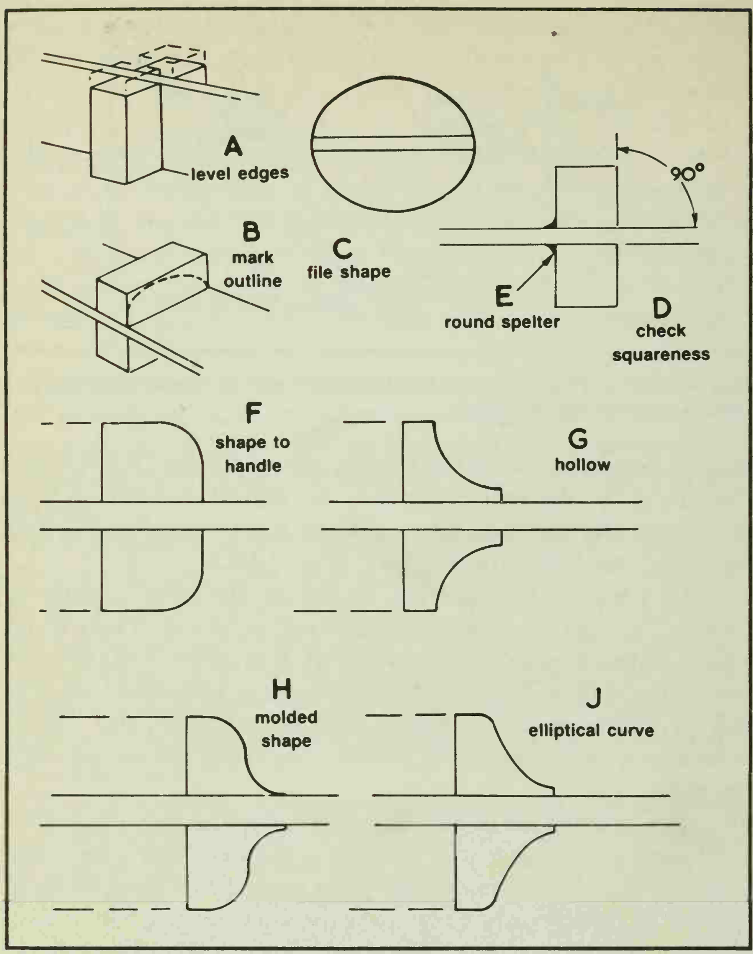


Fig. 7-11. Bolsters are usually fitted as squares then profiled to match the handle and formed toward the blade.

belt sander. Removing brass or other soft metal is not advised on a grinding wheel. It tends to clog the spaces between the grits and spoil the wheel for grinding steel, at least temporarily.

If necessary, the surfaces of the bolster are filed or sanded flat, so there is a reasonably rectangular block of metal around the knife to be shaped (Fig. 7-11B). Doing it in this way makes it easier to get a balanced appearance. If shaping is done directly from uneven surfaces, there is more risk of one side not matching the other.

Usually the cross-section is made elliptical (Fig. 7-11C). Work this to shape before doing any lengthwise shaping. The side toward the handle slabs should be flat and square to the tang if possible (Fig. 7-11D). If there are any errors due to misplacing the parts during brazing, or for any other reason, and the surface cannot be trued by filing or work on the belt sander, aim to get the outer exposed edge true. If there are any flaws nearer the tang, it should be possible to trim the wood so that a good fit is made around the rim and allowance made lower down to suit any uneven metal.

If there is an excess of spelter around the blade, it can be removed with a file or on the edge of a sanding belt. The angle can be slightly radiused (Fig. 7-11E).

There are several ways of finally shaping the bolster. Examination of knives offered for sale will show the usually acceptable patterns. There may be a curved slope down to the blade from a part that continues the line of the handle (Fig. 7-11F). Instead of the convex curve, there may be a concave one (Fig. 7-11G), either going right down to blend into the blade or stopping just above blade level. This can be filed, but it can be worked on the edge of a sanding belt. In most knives the concave curve goes straight across, blending into the edges of the blade. Either simple section can be developed to start convex and finish concave (Fig. 7-1H), and this can be further altered so that the convex part is greater or, more commonly, the concave part is more, with only a small convex curve blending into the flat continuation of the elliptical handle section (Fig. 7-11J).

A sheet metal finger guard can be used with the extended end bent back. If a solid bolster is made to extend into a finger guard, however, it can be made in one piece, and notched to slip over the blade (Fig. 7-12A), still keeping the notch on the knife back and grooves on each side for spelter, like the arrangement of two parts. The guard extension can be left unshaped until after brazing. After brazing, the back is brought level and curved to match the handle (Fig. 7-12B). The side toward the blade has its shaping continued on to the finger guard, but there can be some curving back from the blade edge (Fig. 7-12C). On the side toward the handle the guard is filed hollow (Fig. 7-12D), and the whole thing is rounded for polishing. Final polishing should be left until after the blade has been hardened and tempered, as the heat will discolor the metal.

If a knife or other tool is made with a round or narrow tang to fit into a hole in a wood or horn handle, a bolster or finger guard can be made in one piece. Drill a hole to make a sliding fit on the tang. Almost certainly the tang blends into the blade with a slight radius. Countersink the hole to allow for this (Fig. 7-13A). If the

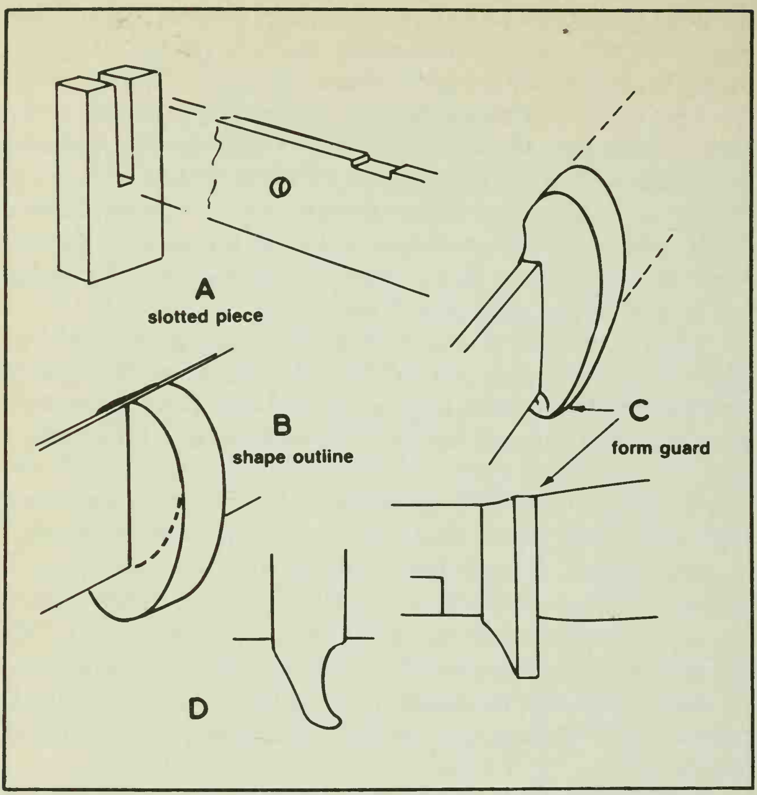


Fig. 7-12. A slotted piece over the blade can be shaped into a finger guard.

blade is thick, a slight bevel where it butts against the bolster will provide a groove for the spelter (Fig. 7-13B), but such a groove on each side of a thin blade might weaken the knife. For a thinner blade, it would be better to have a groove across the bolster made with a hacksaw (Fig. 7-13C). This can be quite shallow, but it should be a loose fit over the blade, and its top can be opened to a slight bevel (Fig. 7-13D).

As with the other bolsters, spelter does not come on the side toward the handle. The knife is supported with its blade upward, and spelter is fused into both sides of the groove and around the countersunk hole (Fig. 7-13E). After brazing, the bolster is shaped in the way described for the two-part bolsters. If the handle is horn, the bolster outline will have to match the horn, which is usually tapered toward the bolster to give a symmetrical section, although it may not be part of a circle or ellipse.

Having a bolster or guard on a knife brings a problem in fitting a handle, which does not occur in a plain knife. It is important that the handle, whatever its type, comes really tight against the bolster. A gap there spoils appearance and could allow dirt and food to get between the parts. If the handle is riveted or held by pins through the tang, there is a double requirement of getting the handle close to the tang and the rivet holes in line. Because of the shape of the assembly, there is no simple way of using normal clamping devices to press the handle tight against the bolster, while fixing is done at right angles to the thrust.

There can be a piece of wood with a slot to go over the blade and another of similar size to push against the end of the handle. These are squeezed on to the knife with two C-clamps (Fig. 7-14A). There should be enough space between to allow holes to be drilled and the handle riveted or pinned, possibly with another clamp across

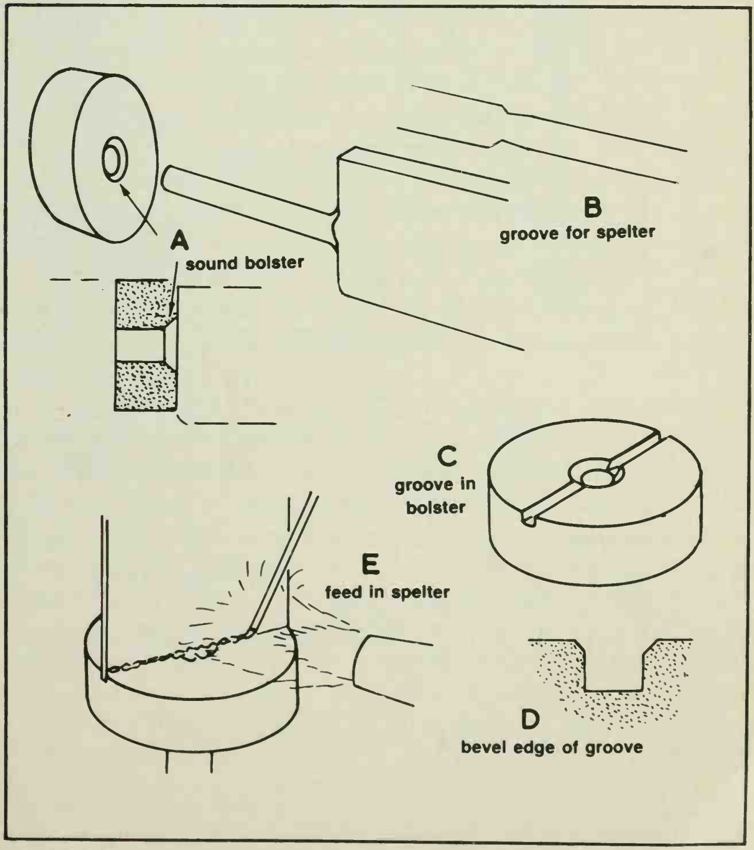


Fig. 7-13. A round-tanged blade can be given a bolster like a slotted washer.

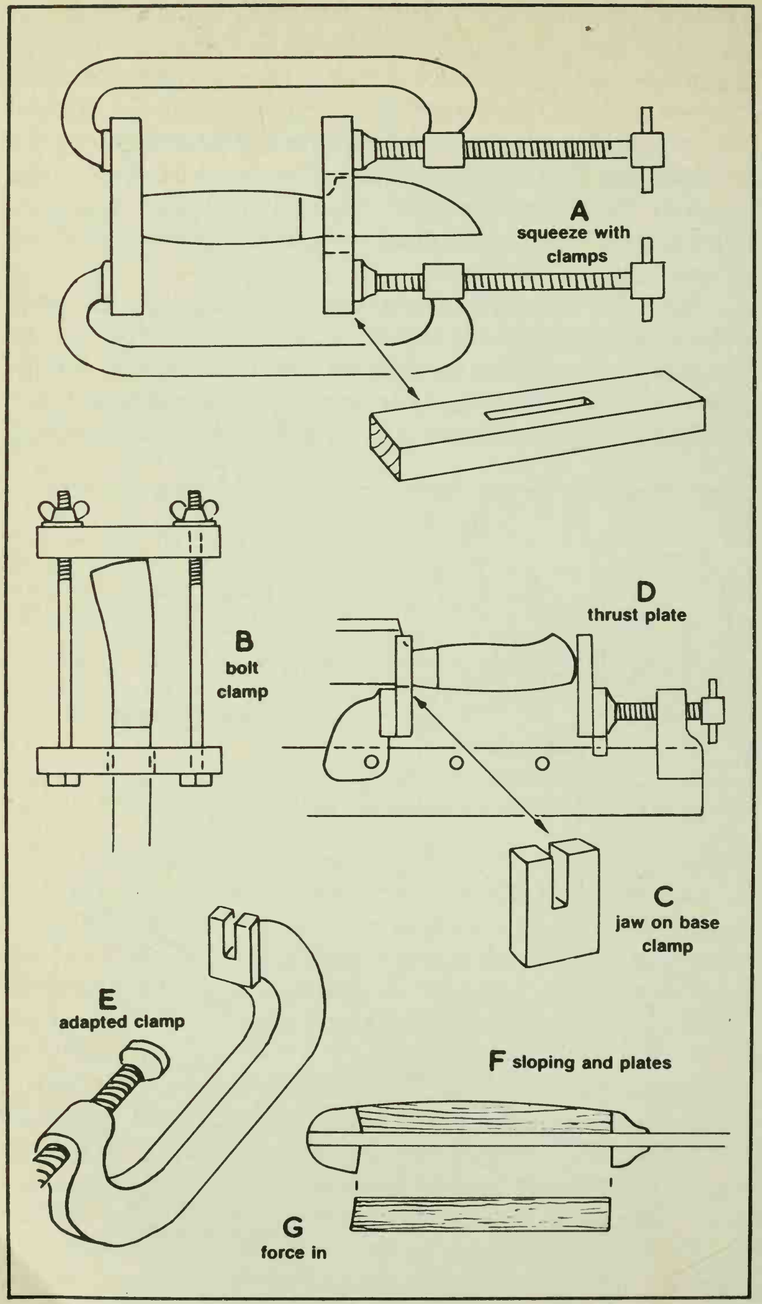


Fig. 7-14. Handle slabs should be clamped tightly against the bolster. Tapering helps tighten against butt plates.

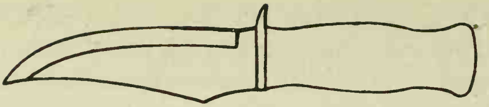
to hold slabs tight while epoxy glue sets. A less clumsy version of the same arrangement has two long screws with butterfly nuts instead of clamps (Fig. 7-14B). The screws may come quite close to the handle, so a C-clamp can pass over holding a glued joint. Epoxy glue between the ends of the slabs or solid handle and the bolster will make a secure bond there. At this stage the handle should be oversize and the bolster used as a guide for shaping that end of the handle.

If many handles and bolsters are to be made, it is worthwhile adapting a clamp to provide thrust on a handle. A pair of sliding heads that fit on a pipe or the edge of a board can be used. If the clamping face is deep enough, it can be cut so that a blade will pass through, but as the tool should be adapted to take blades as deep as you expect to make, it will probably have to be extended. If welding equipment is available, pieces of $\frac{1}{4}$-inch steel can be welded on (Fig. 7-14C). Otherwise, the steel extensions can be drilled and bolted on. In any case, the sliding head has the groove, and the screwed end provides the thrust (Fig. 7-14D).

Other types of sliding head clamps could be adapted in the same way. A large C-clamp may have a slot cut in its fixed end (Fig. 7-14E). The slot needs to be fairly deep to give clearance to deep bolsters, so choose a clamp with a large pad and make sure it opens far enough to accommodate the largest handle you expect to make.

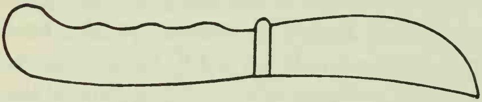
With sliding or C-clamp adaptions, there is the advantage that there is plenty of room for drilling, riveting, and clamping the slabs or cut end of a handle on a part-tang knife, without disturbing the endwise thrust.

A further problem comes if there is a knob or butt plate at the other end of a slab handle. There is no method of getting a tight fit in both directions by any method of clamping. If possible, let the inner faces of the end piece be given in a slight sloop (Fig. 7-14F). If the slabs are given a similar slope, but made slightly too long—probably with the bottom of the slope the length the top appears to be (Fig. 7-14G)—squeezing the slabs in with clamps or in a vise should ensure the tightest possible endwise fit. How much overlength to allow depends on the wood. Harder wood will need less extra on the end than softer wood. A very hard close-grained wood, like ebony or box, would have to be almost down to size. Do not make a trial assembly, as that would wear the ends of the slabs. Clamp the joint together with glue and pins in one action.



Chapter 8

Knives with Bolsters



Whether a knife is given a bolster or guard depends on several factors. Knives for the same purpose can be made with or without bolsters, and both types may be quite effective. There are many examples of things, like carving knives, that may be without a bolster, with a simple bolster no wider than the handle, or with a large bolster extended to make a guard. Adding a bolster is generally considered to be an improvement, both in appearance and serviceability. Knives for similar purposes cost more with bolsters or, if made by the owner, involve more work of a more difficult type.

While a great many knives may be found with and without bolsters, some should always have bolsters or guards. A bolster strengthens the knife. Strength might be built into a knife without a bolster by using thicker steel, but generally a lighter construction with a bolster gives a knife a better balance and more efficient and comfortable handling. If flexibility in the blade is a requirement, yet heavy use is anticipated, there should certainly be a bolster to give strength and stiffness at the point most likely to be subjected to a breaking stress. Heavier knives, such as those used for skinning and hunting, should always have bolsters extended into guards. The only sheath knives that might be without guards are those made like butcher knives for seamen and lighter outdoor use.

An individual knifemaker, who develops a skill in making bolsters, will usually prefer to make his knives with bolsters, even when plain knives might give satisfaction. A nicely made bolster gives a finish to the end of a handle and a well-made bolster or guard enhances the appearance of a knife so that most people would regard it as a better piece of craftsmanship than a knife with a plain handle, no matter how well it was finished.

In this chapter, there are specimens of knives with bolsters and guards that can be used as examples for many variations and for the treatment of knives for other purposes. There are a great many applications of bolsters, guards, and end plates or other metal additions that can improve the appearance and usefulness of handles and blades. Once the straightforward making of the steel parts of knives has been mastered, there can be considerable satisfaction from producing individual designs in handles.

UTILITY KNIFE

A fairly small general-purpose knife with a dropped edge may be for kitchen or camp use, or it may make a bench knife for several types of craft work. For light use it could be without a bolster, but it can be made into a much more attractive tool with a neat bolster (Fig. 8-1A). The dimensions shown are about the minimum useful

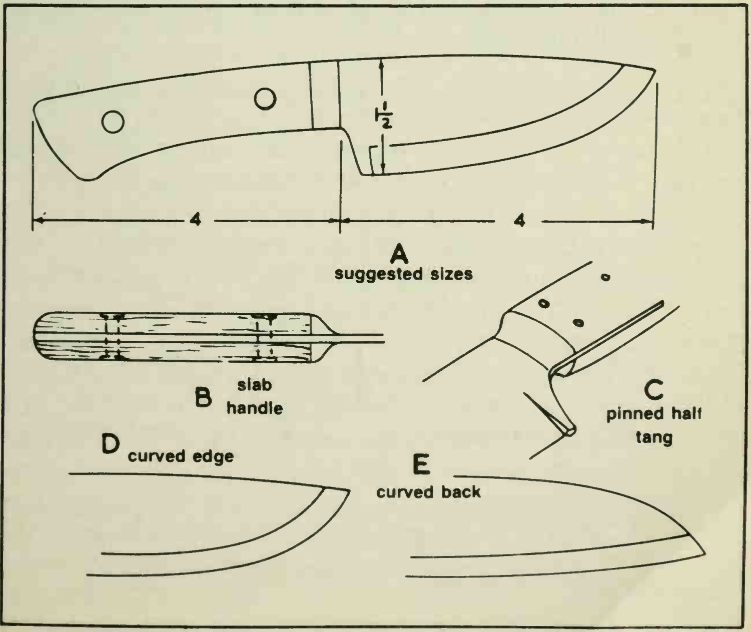


Fig. 8-1. Slab-handled utility knife with bolster, full or half tang, and a choice of blade shapes.

size. They could be increased to allow for the cutting needs.

The tang could be full with only two rivets (Fig. 8-1B), or there could be a half tang fixed with three pins (Fig. 8-1C). The back of the blade could be straight, but it is more pleasing with a slight curve, then the cutting edge is with a curve up to a point (Fig. 8-1D). That suits the majority of needs, but for carving and leatherwork it may be better to reverse the arrangement so that the cutting edge is straight, or nearly so, and the back curves down to a point (Fig. 8-1E). Having the blade fairly wide allows a thin edge with adequate stiffness farther back.

Cut the steel to the profile and drill holes for rivets or pins (Fig. 8-2A). Allow for the thickness of the bolster and a curve down to the edge clear of it. There can be extra holes in the tang for epoxy additional to the pins, but in a small knife the handle should be secure enough with epoxy glue between the surfaces and the pins or rivets. Steel about $\frac{1}{16}$ inch should be satisfactory.

Mark a shoulder on each side of the blade and grind the blade to it (Fig. 8-2B). This will have to be a slightly rounded taper from near the back (Fig. 8-2C), with only a small amount left with a parallel thickness for stiffness (Fig. 8-2D). This size of knife is unsuitable for hollow grinding or giving a flat taper with a definite break between the taper and the parallel part unless much thicker steel is used (Fig. 8-2E).

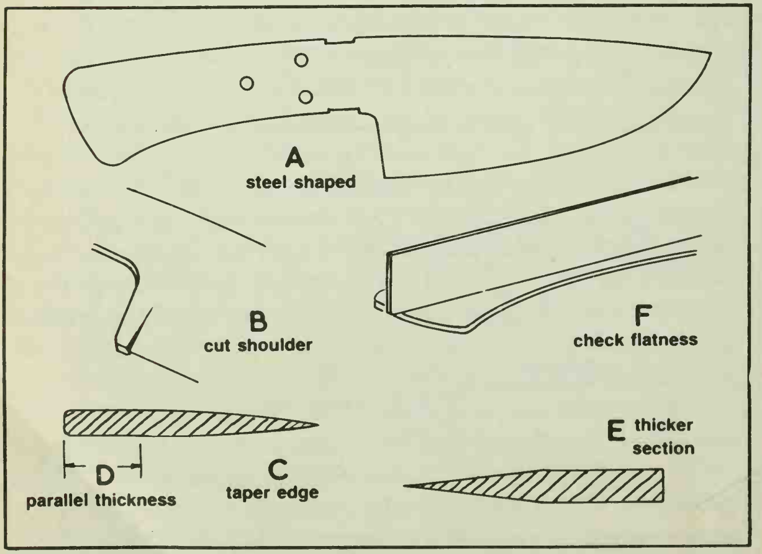


Fig. 8-2. Preparing the blade and tang of a utility knife.

If the steel is not already clean and level, grind the surfaces of the tang smooth with a coarse grit belt sander. Be careful not to round the edges. Check flatness by using a straightedge and looking toward a light (Fig. 8-2F). Smooth the blade with successively finer belts, be careful not to round the shoulder excessively nor to carry any rounding of the back of the blade under where the bolster will come.

The bolster should be planned with the handle, so the slabs for a full-tang handle or the solid block for a half-tang one should be drawn and cut to approximate shape at this stage to match the intended bolster. As the brass or other metal for the bolster will probably have to be a stock size, this may determine the width and thickness of the wood where they meet. Have the wood slightly oversize for trimming after assembly. There is little difficulty in bringing wood down to the size of a bolster, but the work is harder to reduce an oversize bolster to match thinner wood. Care at this stage and maybe a few rough sketches will result in a pleasing finished knife.

If the bolster is to be fixed with hard solder having a melting point below the tempering temperature, harden and temper the blade before fixing the bolster. If the bolster is to be brazed, do this before hardening and tempering. In any case, make sure the first assembly allows enough metal for you to work the final shaping. Check to be sure that there is sufficient spelter or hard solder to fill all spaces, and there will not be any gaps appearing when you file or grind down to size.

To guard against getting the bolster unsymmetrical, bring it first to a rectangular section (Fig. 8-3A) and see that the side toward the handle is at right angles to the tang and that both sides match (Fig. 8-3B). The side toward the blade is not as important at this stage. Work the cross-section to an ellipse (Fig. 8-3C) or to a flat section with rounded ends to match the handle slabs (Fig. 8-3D). It is this shape that will determine the sections the slabs have to be where they meet the bolster, so get a shape that will be practicable and give a pleasing appearance. Usually the handle continues the line of the bolster (Fig. 8-3E), but it could be made larger and curved down to it (Fig. 8-3F). If this is done, it has to be even all around, and the bolster part should be reduced slightly in width so that the tang is curved in the same way as the slabs (Fig. 8-3G).

On the blade side of the bolster, a simple hollow is most effective for a small knife (Fig. 8-3H), blending into the blade. If

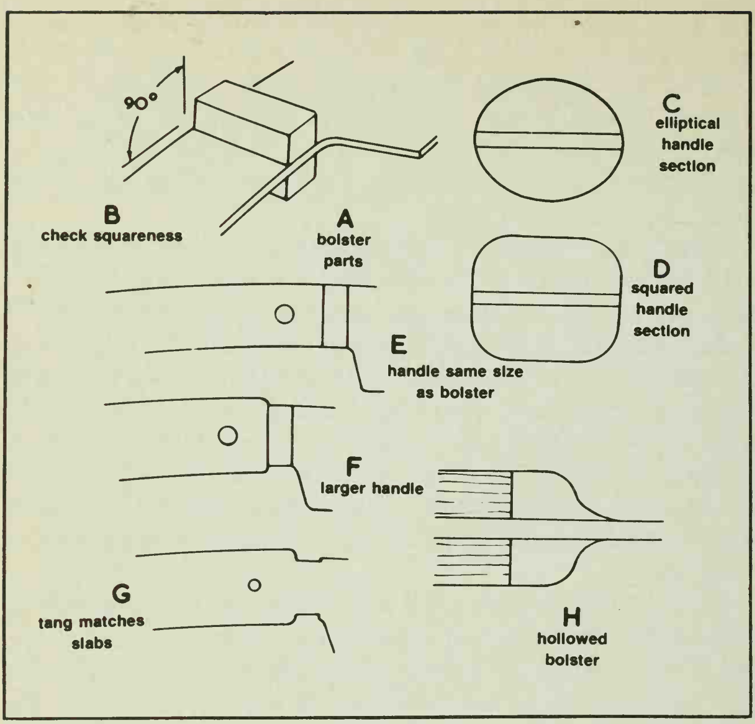


Fig. 8-3. Handle and bolster details for a utility knife.

the blade is already hardened and tempered, the bolster and blade can be further smoothed with finer abrasives and given a polish, leaving just the final polishing and sharpening to be done after the handle is finished. If hardening and tempering are yet to be done, the steel can be given a fine abrasive finish first, with any flaws ground out and all of the blade made smooth. As the bolster hardness will not be affected by the heat-treatment, it does not matter if that it is made smooth at this stage or later. The surface will be discolored in any case, and it will be necessary to use a fine abrasive and polish after heat-treatment.

Prepare the slabs or the solid block for the handle so that it butts closely against the bolster. Trim it close to the final outline but leave a small amount for final shaping after fixing. Put the wood in position and mark the shape of the bolster on the end. Trim the end close to this if it is to be a flush handle. If the handle is to be larger than the bolster, use the marked part as a guide for trimming uniformly. Make sure the slabs are flat where they meet the steel, or make sure the slot in a solid handle is a good fit on the half tang, and it will be neither slack nor liable to split the wood by being too tight.

Mark the holes in the wood and drill them. Fix the handle with epoxy glue and pins or rivets as described for plain knives, but use one of the clamping devices described in Chapter 7 to push the handle tight against the bolster. Keep this pressure on and clamp the other way until the glue has set. Shape the handle as described for earlier knives. With rivets or pins centrally placed, the outline can be to an elliptical section, but there is better control for finer work, such as carving, if the surfaces of the wood are flat and only the edges rounded. Sand the handle smooth and finish it with oil or varnish. Give the blade its final polish and sharpen its angle.

CHEF'S KNIFE

A knife for chopping food on a board should have a bolster if it is fairly large. A smaller version, with a blade only a few inches long, may be of the plain type without a bolster, but for chef's use the handle should be about 5 inches and the blade up to 9 inches. A bolster between the two is advisable for strength and appearance.

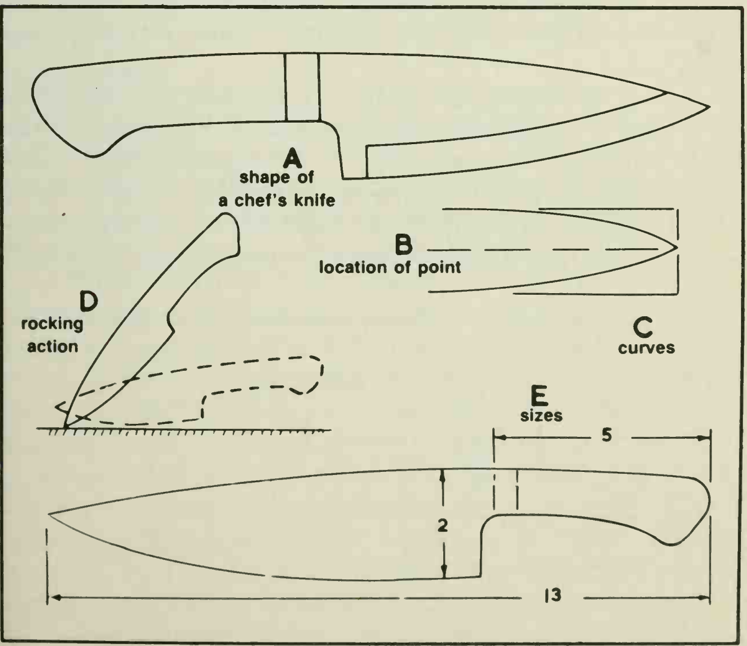


Fig. 8-4. Chef's knife details.

A chef's knife of this size (Fig. 8-4A) should have a quite deep dropped edge and a full tang if it is to be durable and not suffer damage in prolonged use. The cutting edge follows a curve from a point that is about opposite the center of the greatest width of the steel (Fig. 8-4B). The curve of the edge is greatest near the point and flatter toward the handle (Fig. 8-4C), so the knife can be used with a rocking motion on the cutting board (Fig. 8-4D).

Construction is generally similar to the utility knife, but as the blade should be stiffer, the steel should be thicker—$\frac{1}{8}$ inch should do for a knife of the size shown (Fig. 8-4E).

At this thickness it is possible to work the blade to a hollow section (Fig. 8-5A) with a parallel thickness for some way down from the back. As the edge should give a similar cutting action throughout its length, the hollow grinding should be parallel with the edge (Fig. 8-5B) and not tapered to the point, as in some knives. There should not be a shoulder because the knife is required to cut for all the blade length when chopping (Fig. 8-5C).

The deeply dropped edge keeps the hand from the chopping board and protects it from the sharp edge. The end of the blade should be curved back into the bolster and handle so that there is about $\frac{1}{4}$ inch of the thick part of the blade (Fig. 8-5D) between the handle and the blade, to give some extra clearance for the gripping hand.

Except for these special features, the making of a chef's knife is the same as a utility knife. Do not thin the cutting edge too much before hardening and tempering, or the contrast between it and the wide piece of thick back may cause the blade to distort during heat-treatment. Experience will show how much preliminary shaping to do. As it is easier to shape the annealed steel after heat-

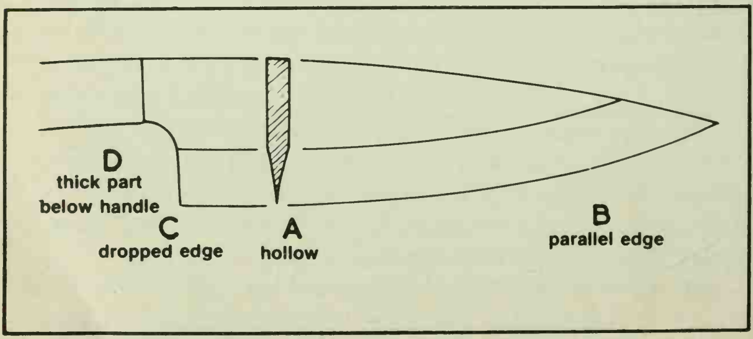


Fig. 8-5. Blade form of a chef's knife.

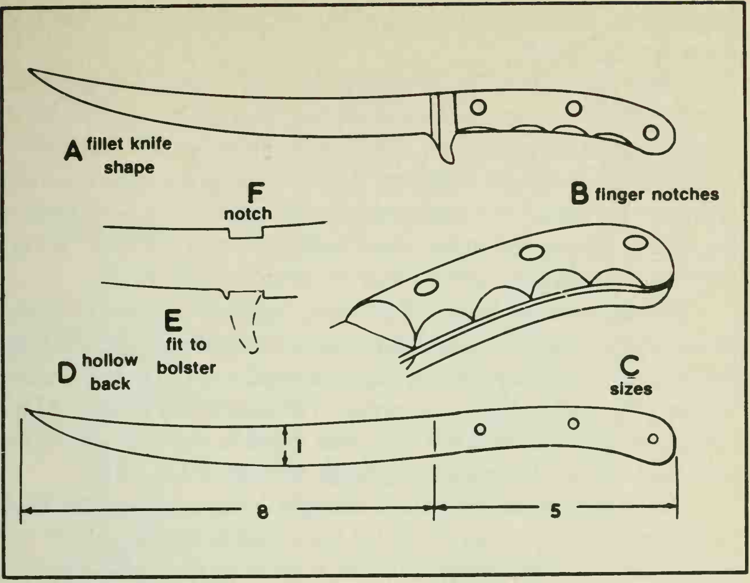


Fig. 8-6. Fillet knife with finger guard and finger notches.

treatment, it is obviously wiser to get the steel to shape as far as possible in the early stages, but not if this means a risk of warping.

FILLET KNIFE

Filet knives are flexible, with thin and narrow blades. Some small ones have blades not much more than $\frac{1}{4}$ inch average width, although these widen toward the handle to give a comfortable grip. Others are wider, but still thin and flexible. To use them properly, it is necessary to have a good safe grip. There are some fillet knives without bolsters, but it is better to have a bolster extended to form a finger guard if the blade is not one with a deeply dropped edge to provide its own protection. If there is a dropped edge, the bolster can be similar to that described for the utility knife. For other blades, there should be enough guard extending to prevent the first finger from sliding from the handle to the sharp edge in use.

It also helps in control and safety to give the handle finger notches. In the knife shown, the notches are in one slab only and do not cross the tang to the other slab (Fig. 8-6A). When a handle is gripped, it is the side where the fingers wrap around that needs notches. The only snag with notching one slab only is that it makes the knife one-handed. A right-handed user needs notches on the side shown, but a left-handed user needs them on the other side.

Curving the handle slightly as well as notching it ensures the best control (Fig. 8-6B).

The sizes shown (Fig. 8-6C) are for an average fillet knife. The handle would be about the same for any size knife, but the blade can be scaled up and down. The steel can be $\frac{1}{16}$ inch or less for a small knife to ensure sufficient flexibility. It is not until the blade has been hardened and tempered that flexibility can be tested, so do not try flexing the unhardened steel as it will not then be very springy, and you are more likely to bend or kink it.

The blade shown has a hollow back, but the whole piece of steel can be marked slightly diagonally from a parallel strip of metal (Fig. 8-6D). The root of the cutting edge curves down to the bolster and handle (Fig. 8-6E), but it is sharpened almost to the bolster. Mark out the shape and cut it out. File and grind to the lines. Keep the part that will go through the bolster parallel (Fig. 8-6F).

The blade should be given a straight V-section from the back to the cutting edge (Fig. 8-7A). At least that is the aim, but it will almost certainly be slightly rounded in cross-section, although that does not matter. What is more important for satisfactory fileting in a general thinning toward the point. Besides grinding across to get the taper to the cutting edge, the blade can be ground in the length (Fig. 8-7B0). This may be done by hand holding only, with the blade sprung to a slight curve against the wheel (Fig. 8-7C) or by supporting it with a piece of wood (Fig. 8-7D). Follow by further grinding on a sanding belt.

Make the bolster by one of the methods described in Chapter 7. Whether the steel is hardened and tempered first or not depends

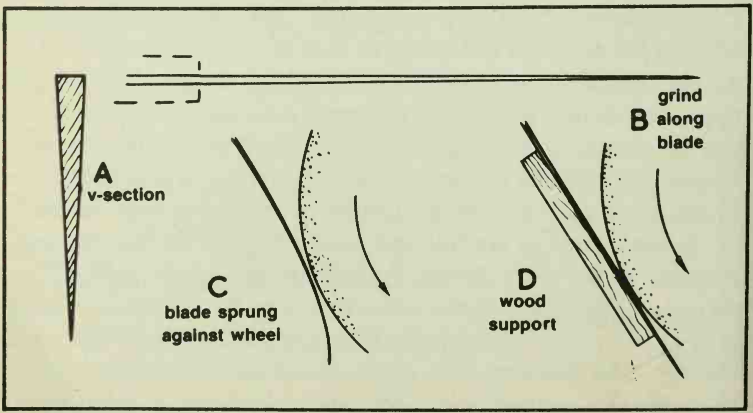


Fig. 8-7. Grinding the thin blade of a fillet knife.

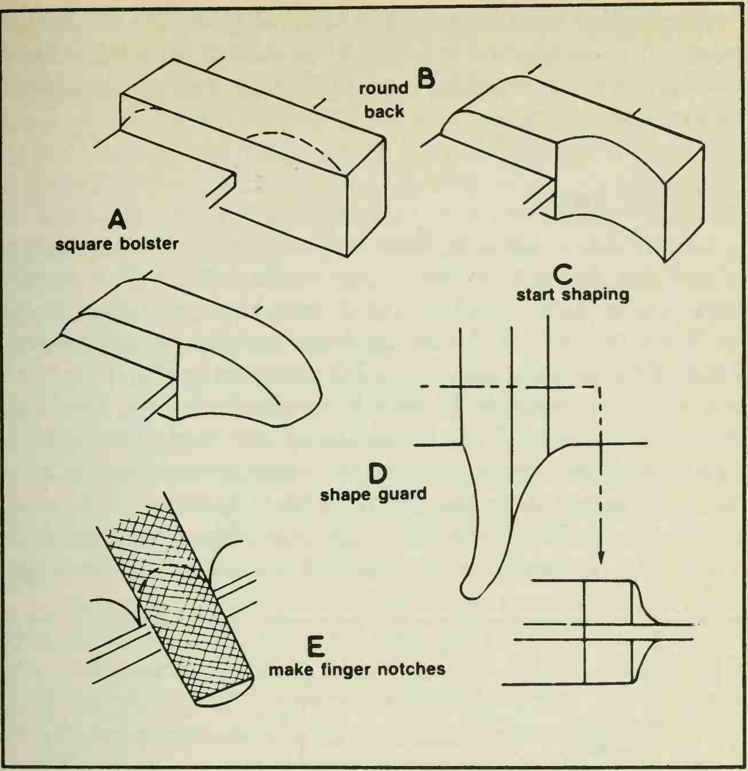


Fig. 8-8. Steps in forming the guard and notches of a fillet knife.

on if you use a low temperature hard solder or braze the joints. Shape the bolster guard with enough metal projecting and get a good rectangular shape after making the joints (Fig. 8-8A). As with a simple bolster, get the handle side true to make a good fit against the handle slabs.

Shape the top of the bolster to the curve the handle is intended to take (Fig. 8-8B). The lower part should be filed to a good hollow so that a finger pressed against it is unlikely to ride over to the blade (Fig. 8-8C). Taper this slightly in the width for the sake of appearance (Fig. 8-8D), but when the hand is pushing the flexible blade around bones to remove flesh, a very narrow guard may become uncomfortable.

The handle slabs are cut to shape and may be fixed before the finger notches are cut in one of them. Bring the outline of the wood to the shape of the tang then round the edges and end. The finger notches are most easily made with a half-round file (Fig. 8-8E).

Abrasive paper wrapped around the file can be used to remove file marks. If a sanding belt is used after notching, be careful that it does not wear the notches unevenly or round the high parts excessively one way.

CARVING KNIFE

As a carving knive is like a butcher's knife, but made more elegant for dining table use, it can be decorated with a shaped bolster. The blade should be 9 or 10 inches long so a good slicing action can be given. With a handle about 5 inches long, this becomes a large knife to make (Fig. 8-9A). Except for its length, the method of construction is similar to some of the simpler knives. The blade is pointed but kept fairly broad behind the point. Thus usually broadens more toward the handle. Some carving knives have dropped edges, but the example has a blade that does not increase very much in width, and a deep finger guard blends into the blade. The handle has finger notches right across, so it is suitable for use

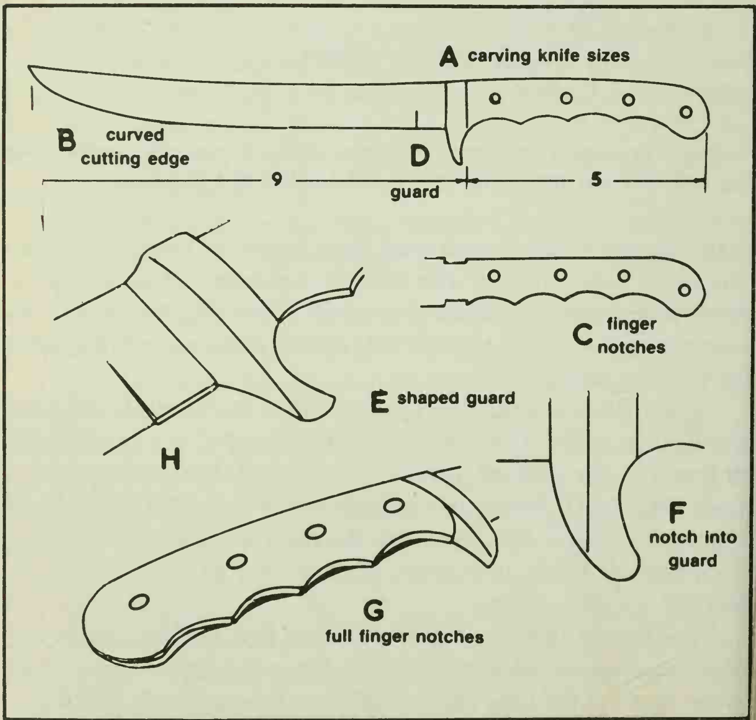


Fig. 8-9. A carving knife with a guard and full finger notches.

in either hand. The blade should be fairly stiff, but slight flexibility toward the point is acceptable.

The blade should be slightly hollow-backed, with the cutting edge sweeping up. This gives a cutting edge that can still be used with a push from the handle as well as with a slicing action, enabling cutting to be done with an inch or so of the edge behind the point in restricted places (Fig. 8-9B). The main part of the blade has a slight taper as it increases in width. A parallel might be just as useful, but the tapered section looks better. The curled end to the handle augments the finger notches in giving a good grip when making heavy and awkward cuts.

Make the steel part, with its tang through the handle (Fig. 8-9C). At the finger guard position, notch and groove the steel, as described in Chapter 7, to allow for brazing or hard soldering. For most purposes the steel should be slightly more than $\frac{1}{16}$ inch thick. It may be as much as $\frac{1}{8}$ inch thick if the edge is to be hollow ground, which makes the knife most effective when slicing meat. However, slightly thinner steel and a straight bevel is almost as good.

The bolster shown extends far enough to make a good guard (Fig. 8-9D). When the metal has been squared and the side toward the handle is true, make a hollow on each side running into the extension and round the leading edge (Fig. 8-9E). The hollow at the other side blends into the first finger notch (Fig. 8-9F).

The handle should be made of attractively grained hardwood and thoroughly rounded to give a pleasant appearance. To a certain extent, a carving knife is an ornament on the dining table, and the handle is a prominent part of the decoration (Fig. 8-9G). The edge of the bolster fits flat against the handle slabs, but at the guard the handle and the hollow finger guard look best if they blend into each other. Brass or bronze rivet heads flush with the wood make better decorative features than smaller pins.

The cutting edge does not go close to the guard, but there should be a shoulder about $\frac{1}{2}$ inch from it so that the steel next to the guard is full thickness. This same size is carried around the forward edge of the guard extension (Fig. 8-9H).

SHEATH KNIFE

The knife worn in a sheath on the belt of a frontiersman, pioneer, or hunter has to serve many purposes, but it is fairly stout and the general shape is based on a skinning knife. Some of the older knives were quite long. Although these can still be made, it is a knife of more moderate length that is likely to be of use to a

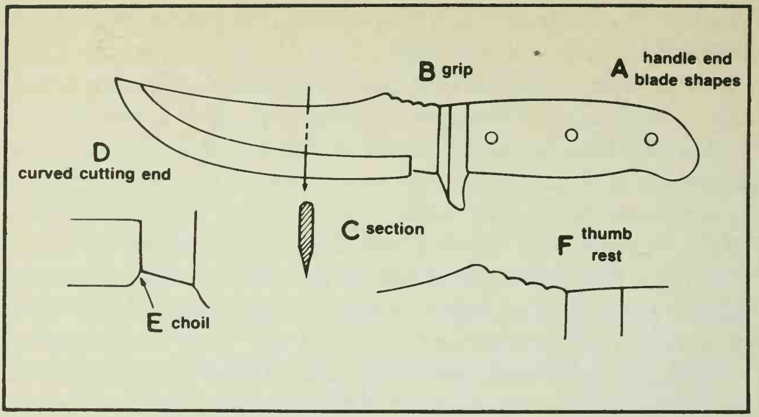


Fig. 8-10. A sheath knife with a gimped thumb rest.

modern outdoorsman, camper, or wilderness explorer. The blade may be up to $\frac{3}{16}$ inch thick for a knife of an overall length of 8 inches (Fig. 8-10A). The blade if fairly wide, and the one shown has the back swept up to make a thumb rest, which is gimped to provide a grip (Fig. 8-10B). Stiffness is provided by keeping the steel full thickness in the body of the knife. The hollow clip back provides a lightening of appearance by its rounding and thinning (Fig. 8-10C). Toward the point, the full thickness is eased down to blend into the hollow-ground bevel that sweeps up toward the point. This part has quite a deep curve, which is a feature of a skinning knife, so the knife can be tilted to bring the handle and guard clear of the skin while cutting with the curved edge (Fig. 8-10D).

The hollow-ground edge can be made a decorative feature, if

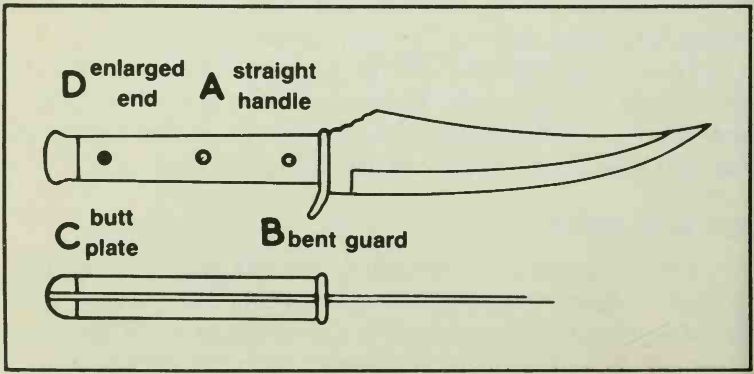


Fig. 8-11. Sheath knife with a slotted guard.

evenly done, as the greater thickness of this knife gives plenty of metal for adequate grinding. Grinding should be done to a shoulder, which looks best if finished with the little nick on the edge called a *choil* (Fig. 8-10E).

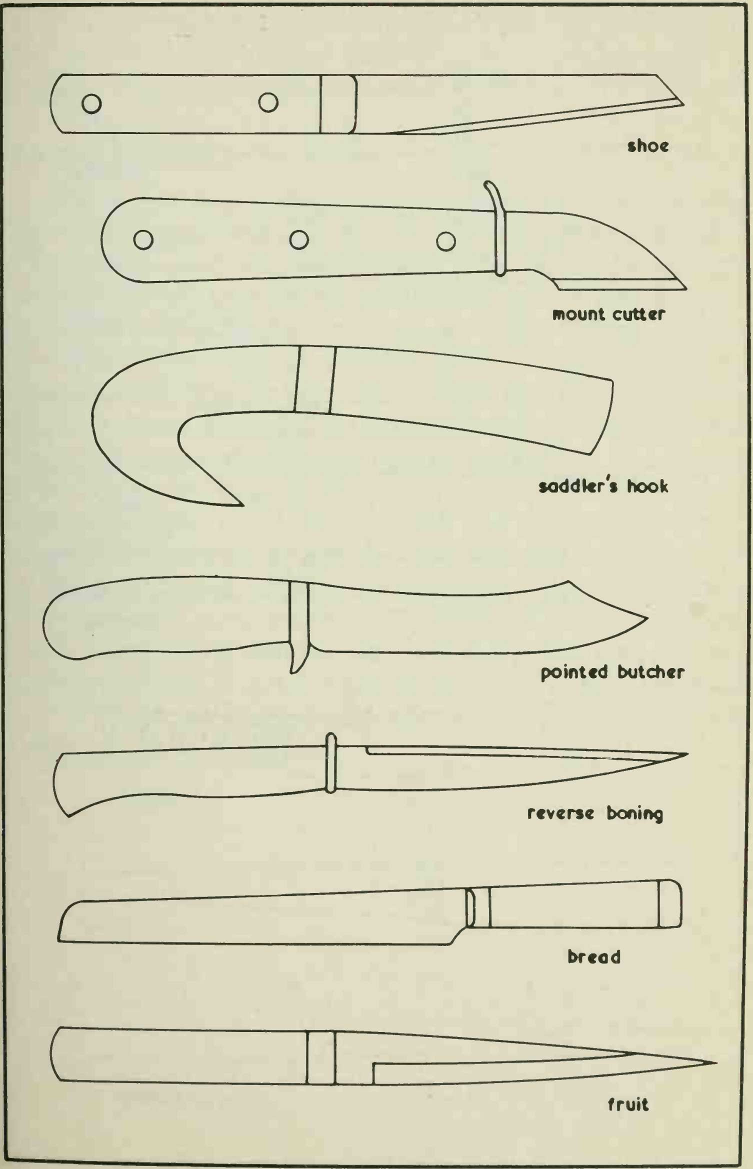


Fig. 8-12. Special-purpose knives with bolsters or guards.

The handle may be plain, or it can be given finger notches. A similar handle to that of the carving knife can be used, with the finger notches blending into the guard. At the other side, the back of the handle and guard blend into the thumb rest, which could be

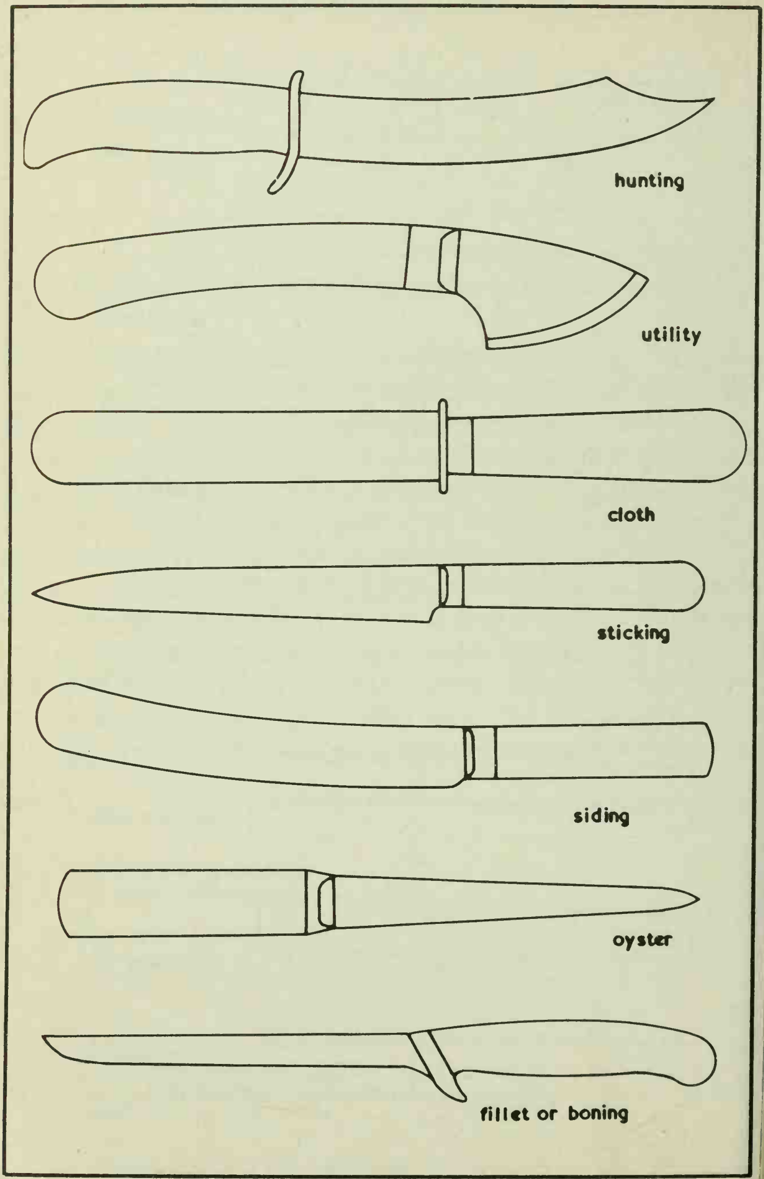


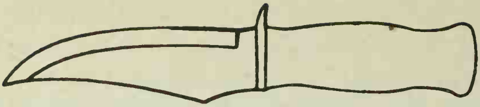
Fig. 8-13. More special-purpose knives with bolsters or guards.

plain, although carefully filed or ground gimped notches help when heavy pressure has to be applied (Fig. 8-10F). A built-up bolster guard may blend into the blade and taper to the thumb rest.

Other sheath knives have straight handles with a slotted guard (Fig. 8-11A). There can still be a thumb rest and the finger guard is bent back at the front of the knife (Fig. 8-11B). This type of handle can be finished with a butt plate (Fig. 8-11C), which might be enlarged slightly to prevent the hand from slipping off (Fig. 8-11D).

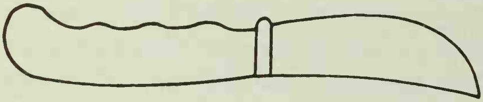
OTHER KNIVES

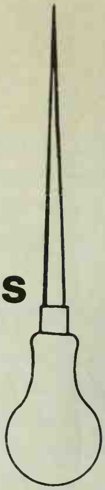
The knives so far described in this chapter cover the common ways of including bolsters or guards between handles and blades. The methods can be applied to many other knives. Some of the knives described earlier with plain handles and no bolsters could be given bolsters. Further variations are shown in Figs. 8-12 and 8-13. The strongest joints are brazed, and this should be the method chosen for knives expected to receive hard use, but hard or silver solder is almost as strong. Anyone without facilities for making these high temperature joints could use soft solder and produce bolsters with just as good an appearance, but a bolster or guard joined in this way might not withstand very rough use and would certainly not hold if it became very hot. The melting temperature is well above that of boiling water, however, so there would be no risk if the knife were washed in hot water. A soft-soldered joint could be reinforced with pins or rivets and should then stand up to all normal use. It should be possible for any knifemaker to use one of these methods and get satisfying results, whatever the limitations of his equipment.



Chapter 9

Special Knives and Tools





Besides the knives already described, there are others for special purposes and many other tools that anyone who understands knifemaking can make by using very similar methods (Fig. 9-1). All the tools illustrated are described in this chapter or elsewhere in the book.

Many of the knives not intended to cut are used for scraping and mixing things. They have to be flexible. This means they should be thin steel and not tempered too hard. Although new steel may be used, it is possible to make many of these knives from steel salvaged from larger coil springs like those from a clock or phonograph. Such steel would have to be annealed and flattened. Tempered steel springs can usually be broken off by gripping them in a vise and bending them backward and forward. A groove can be scored across with the edge of a grinding wheel; then the steel can be snapped off. Anneal by heating to redness and leaving to cool as slowly as possible. The curve can be hammered out of a piece of spring, but be careful of denting the surface with the edge of a hammer. As the steel is already thin, there will not be enough thickness to allow for grinding out dents.

PALETTE KNIVES

The names comes from the use of a flexible knife by an artist to mix colors on a palette, but *palette knives* today are mostly kitchen tools with long flexible blades to scrape around the curves inside

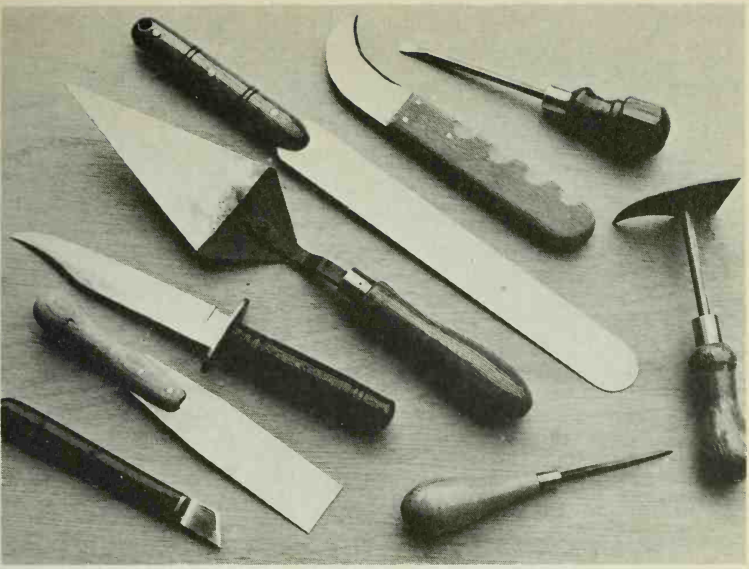


Fig. 9-1. A selection of special knives and other tools made by similar methods.

bowls and dishes. Sizes vary, but the important part is a long parallel blade with a rounded end (Fig. 9-2A). In the simplest example the blade goes between slabs, which extend onto the blade to provide some stiffness there (Fig. 9-2B). If the steel is already quite thin—under $\frac{1}{32}$ inch or 16 to 20 gauge—it can be left the same

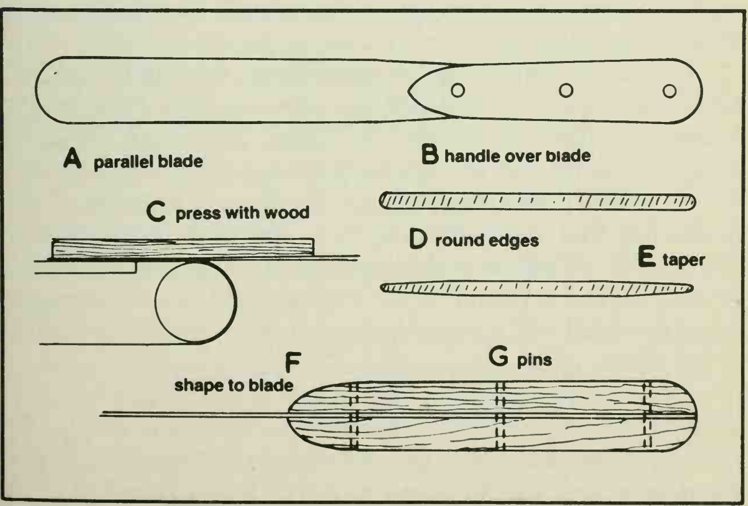


Fig. 9-2. A palette knife with a plain slab handle.

throughout its length. If it is nearer $\frac{1}{16}$ inch—and it should not be more—there is some advantage in keeping its full thickness through the handle and a short distance onto the blade and thinning it toward the tip.

After the outline has been cut, this tapering can be done by grinding lengthwise, either on a grinding wheel or using a belt sander, but pressure is put on with a piece of wood (Fig. 9-2C). This can also be used behind the steel when buffing.

There must be no roughness or sharpness around the edges, and even at the thinnest parts all angles and roughness should have been ground away and the finished edges left rounded, either a full semicircle on a parallel thickness (Fig. 9-2D) or a rounding on a slight taper from the center (Fig. 9-2E). Because there is little difference in thickness anywhere in the whole piece of steel, there is little risk of distortion or warping during heat-treatment. Drill the tang, and work the blade smooth with successively finer abrasives. Some buffing may show if abrasive scratches from the coarser stages have all gone; however, leave final buffing until after the surface has suffered discoloration under the flame.

Harden normally. Temper evenly farther than the oxide color for a cutting knife. How far to go with a particular steel may have to be found by experiment, but the color will certainly be past the dark brown and into the purple. It may deepen to blue. It should be possible to flex the end of the knife so that it springs back straight. If it tends to stay slightly curved, tempering has been taken too far. If tempering is not carried far enough, there is risk of the blade's breaking.

The handle slabs should be cut to shape, with a little to spare, but it is advisable to round the edges partly and blend this into the curved part that will go over the blade. That much should be brought to its finished shape (Fig. 9-2F) because it would be difficult to work on the overhanging part after fixing. The handle shown is attached with epoxy glue and three pins (Figs. 9-2G and 9-3). Because the tool will be used with food, it is advisable to use a close-grained hardwood that is sealed with several coats of waterproof varnish so that it will not absorb food juices or suffer from washing in hot water.

A larger palette knife is made with a bolster (Fig. 9-4A). The blade is also wider, and it curves back to the bolster and handle width. Too abrupt a reduction in width there would cause weakness. There is no need for the bolster to extend because a guard is not needed. It could be rounded onto the blade (Fig. 9-4B), or hollowed

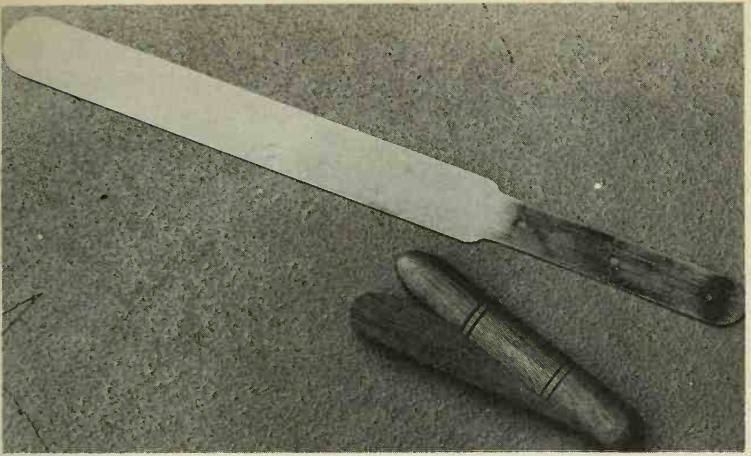


Fig. 9-3. A palette knife with handle slabs made by turning the solid wood and cutting along its middle.

in the way more common on a cutting knife (Fig. 9-4C).

Except for fitting a bolster, the large knife is made in the same way as the first one. Thinning the blade should be gradual so that the tip is quite flexible and will bend around tight curves. Nearer the handle it may be stiffer, although there should still be some springiness in it.

Fix the handle slabs in the same way as for a cutting knife, with pressure against the bolster, so there are no gaps to trap dirt or food. The handle shown has two pins with a central rivet (Fig. 9-4D). There could be all pins or all rivets, but the combination is done for the sake of appearance.

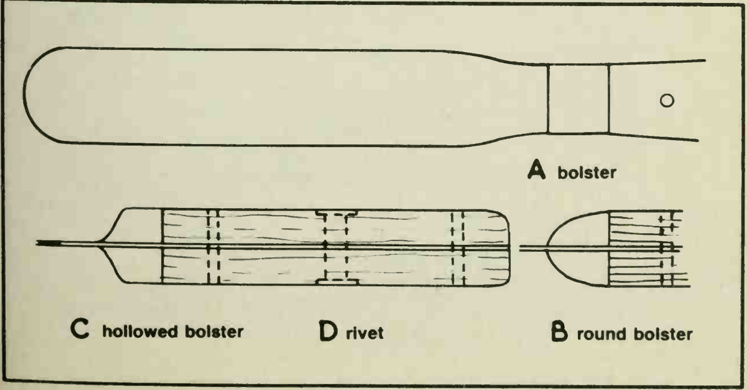


Fig. 9-4. A large palette knife with rivet and pin handle.

A kitchen spatula may be plastic or wood as well as steel. This is really a variation on the palette knife, but it is not as flexible. It is used as a kind of spoon for lifting food and mixing it. A steel one is made like a palette knife, but the blade is wider toward the end. It could be rounded or pointed (Fig. 9-5A), or given a diagonal straight edge, which serves as a scraper (Fig. 9-5B). For its size, the steel should be a little thicker than for a comparable palette knife. There need not be much tapering of thickness toward the tip, and tempering may be slightly harder so that the blade is not so flexible. Such a spatula is very much like a putty knife, described later.

Other knives of similar construction are used with butter, jelly, and cheese. A butter knife may be like a small palette knife (Fig. 9-5C). The tip should be flexible enough for spreading on bread. A variation has a curve one way toward the tip (Fig. 9-5D). This design is considered better for spreading.

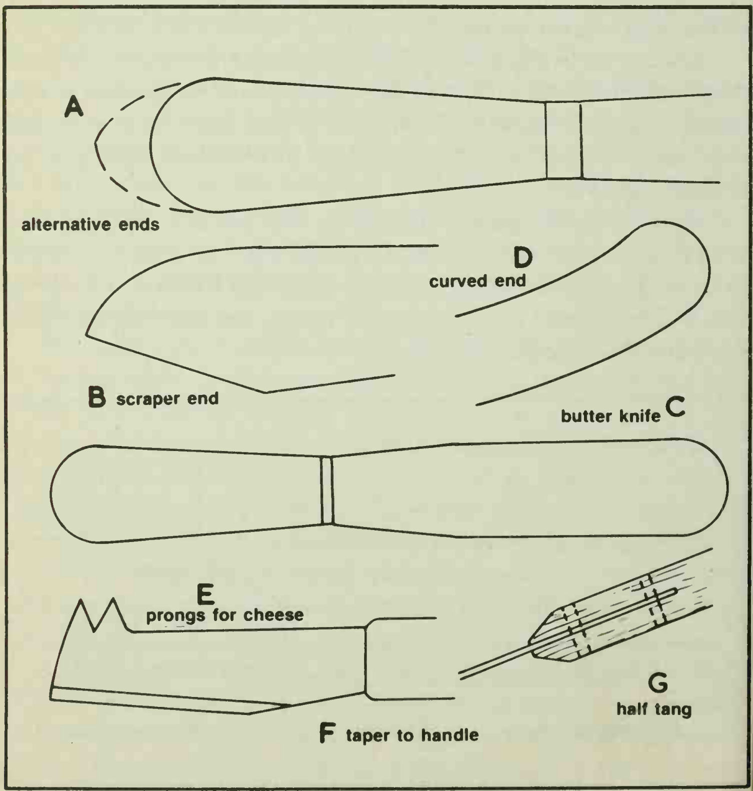


Fig. 9-5. Spatula, butter knife, and cheese knife.

A knife for cheese is intended to cut as well as spread. One type has the back arranged as a two-pronged fork for picking up the cheese after cutting (Fig. 9-5E).

Cut the steel to shape. The fork prongs will have to be filed. Taper the blade in thickness toward the cutting edge. The part toward the handle is not sharpened (Fig. 9-5F). As the strain on this knife is not great, it could be arranged with a half-tang handle, with or without a bolster (Fig. 9-5G).

A cheese knife does not have to be flexible, so it could be made from steel about $\frac{1}{16}$ inch thick. Only the cutting edge needs to be at the knife temper of deep straw. After hardening and rubbing the blade part bright, it is possible to temper this small knife with a torch while it is held in the air with tongs. Play the torch flame along the back of the blade and the tang. These parts, and the fork points, may deepen to blue, but watch what is happening at the cutting edge. Colors will spread to this thinner part. If heating has been fairly uniform along the back, the spread should be even. When deep straw reaches the edge, quench the whole knife quickly. Polish the steel and complete the knife in the usual way.

GLAZIERS' AND DECORATORS' TOOLS

A glazier uses a putty knife that has a broad blade shaped for pressing putty into a window frame. A decorator uses a broader

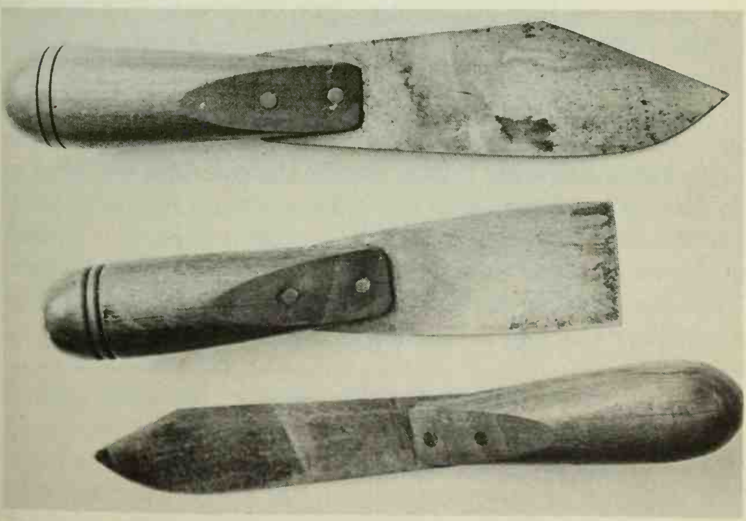


Fig. 9-6. Three putty knives with different blades, but all fitted in slots in turned handles.

blade tool for stripping paint. For heavy use both should be made with bolsters and full tangs, but for occasional glazing and paint stripping the blades could fit into the handles without bolsters and may have full or part tangs. The action of using the tool puts strain where the blade enters the handle, so rivets rather than pins should be used to resist any tendency for the handle to be forced open (Fig. 9-6).

The basic putty knife has a spear blade, with symmetrical rounded edges toward the point and a blade 4 to 5 inches long (Fig. 9-7A). There has to be some flexibility toward the point, so taper the steel in thickness from about $\frac{1}{16}$-inch in and near the handle. The edge need not be as rounded as a palette knife, but there should be no sharpness anywhere.

A more popular version has a clip blade (Fig. 9-7B). This is similar to the first type except one side has a straight part (Fig. 9-8), which is better for smoothing the angled putty surface. It should be made with a similar flexibility to the first type.

A glazier also uses a stiffer chisel putty knife. This is made from thicker steel, which broadens to the slightly diagonal end (Fig. 9-7C). The steel should be $\frac{1}{16}$ inch or slightly more in thickness and taper slightly to the tip, which is thinned, although it is not given a cutting edge like a woodworking chisel.

As far as a knifemaker is concerned, a filling knife is a broad putty knife. This has a very flexible broad blade and is used for spreading wood filler and similar pastes. The blade may be up to 5 inches wide, but 3 inches is more common and easier to make. There should be a good bolster, and the sides should curve back to it so that there is no abrupt narrowing to weaken the change to the handle width (Fig. 9-7D). As with a flexible putty knife, the blade has to be ground thinner toward the end. This will have to be done while holding a piece of wood as a stiffener behind the steel. Check across the width frequently because it is possible to take off too much at one point while not removing enough at another. The edge should be straight and thin, but not sharp. There can be a very slight rounding at the corners, to prevent them from digging in.

Paint scrapers are made in a similar way. The blade size can be from 5 to $1\frac{1}{2}$ inches to 6 by 4 inches (Fig. 9-7E). There should be some flexibility in the blade, but not as much as in a filling knife. The straight edge has to remove paint that has been softened with a torch flame. It does not need to have a cutting edge, as a thin knifelike edge might cut into the wood behind the paint, but it

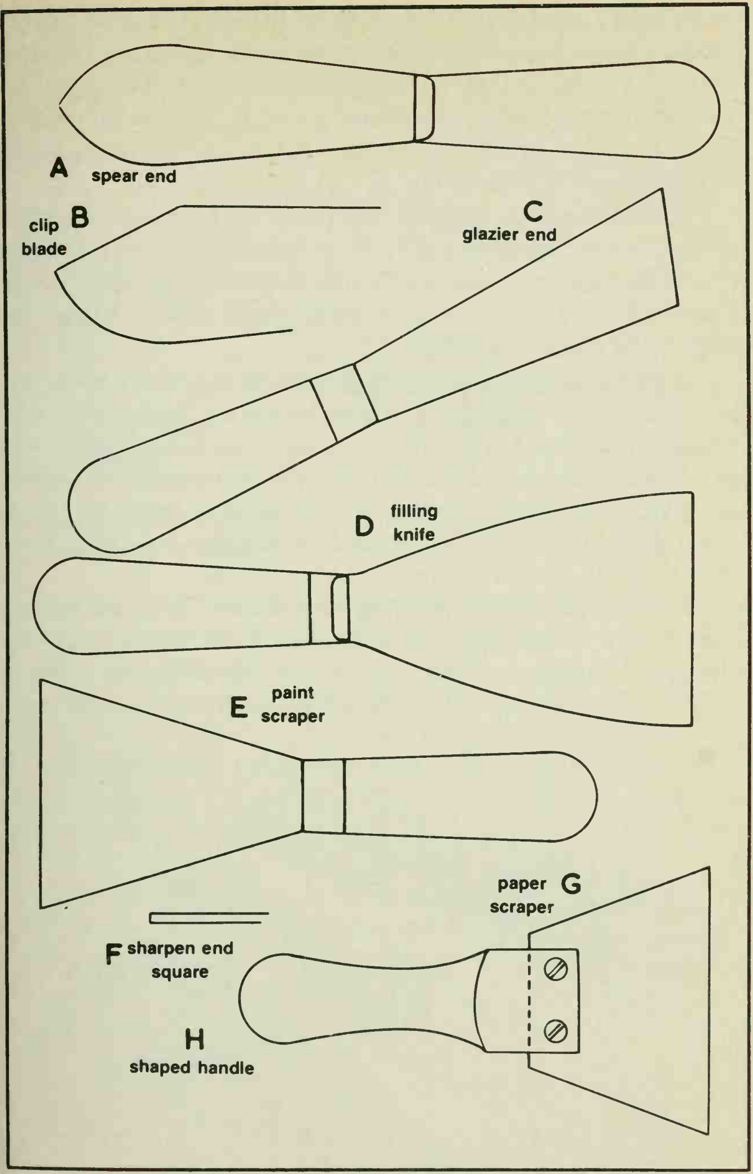


Fig. 9-7. Putty knives. Paint and paper scrapers.

should not be rounded. A thin edge with an angular section is most effective (Fig. 9-7F).

A paint scraper may also be used for removing wallpaper and other wall coverings. A wall scraper made for the purpose is usually stiffer than a paint scraper. It could be made in the same way as a paint scraper or putty knife, but another version uses a flat steel plate in a cut handle (Fig. 9-7G), something like a half-tang handle. The handle may be shaped from hardwood by hand or sanding, or it may be turned on a lathe, leaving a square end where the blade is to be attached (Fig. 9-7H).

The blade may be held with two rivets, but nuts and bolts might be used, so one handle could be fitted to several blades that could be stiff for paper scraping and flexible for paint scraping or filling. This would be a way of using up small pieces of steel that are too short to be made with tangs.

A glazier needs knives for removing old hard putty when broken glass has to be replaced. These knives are normally hit with a hammer, so their backs have to be thick. There is no reason why wooden handles should not be used, but traditionally the knives are given leather slab handles. A plain *hacking knife* (Fig. 9-9A) has a straight handle, while a cranked *chipping knife* (Fig. 9-9B) may have the handle tapered and lifted a little.

The steel should be about $\frac{3}{16}$ inch thick. The blade point is angled back a little (Fig. 9-9C), and the blade should be given a straight or slightly rounded taper for the full width (Fig. 9-9D). A very fine edge is not wanted. While being driven into old putty,

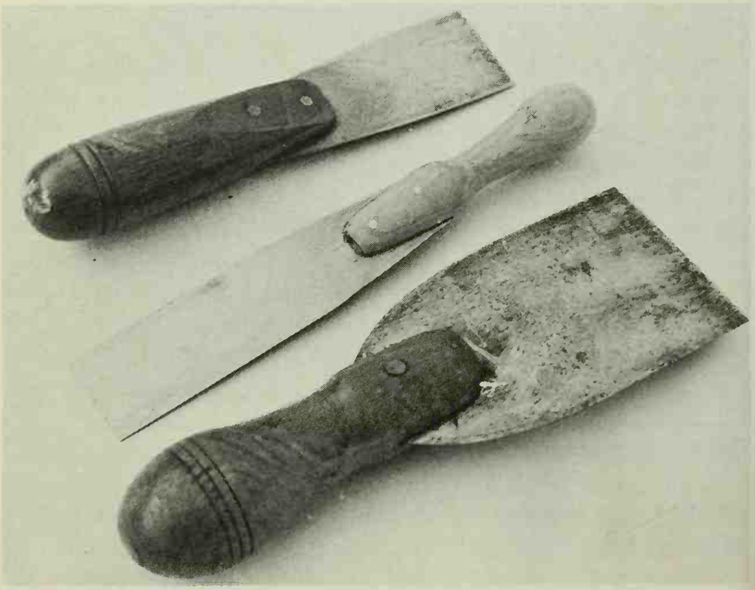


Fig. 9-8. Paint scrapers are made like putty knives only wider.

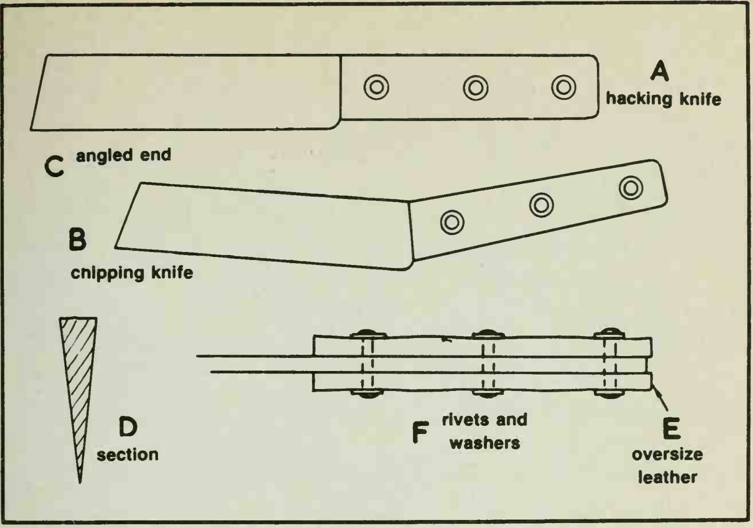


Fig. 9-9. Glaziers' knives.

the edge may hit nails and will certainly touch splinters of glass, so a fine edge would soon be lost. The action is as much that of a wedge as of a knife.

The handles are pieces of thick hide, cut slightly oversize and left that way so that they project around the tang (Fig. 9-9E). The usual fastenings are three copper rivets, taken through washers and spread over them. Hammer down enough to remove any sharpness, but otherwise leave the rivet ends above the surface of the leather (Fig. 9-9F).

A knife with a very curved hooked end may be used by a plumber on sheet lead. A similar knife is used for cutting floor covering and packing or gasket material in machinery (Fig 9-10). Knives can be similar for all these purposes, but a full tang and thicker blade is used for a plumber's knife (Fig. 09-11A). There may be a half tang and a lighter more curved blade for floor covering (Fig. 9-11B). There is no need for a bolster, so the handles may be wood tapering on to the blade.

For cutting lead the steel may be $\frac{1}{8}$ inch thick, but other knives can be much thinner. Cut the profile and thin the inner curve toward the point. Normally, only the point is used, but the blade may be sharp for perhaps 1 inch from the point. Do not sharpen close to the handle, where the hand may slide onto the steel during a cut needing heavy pressure. As the tool wears, the hooked blade will become shorter and straighter, so a new knife is made with

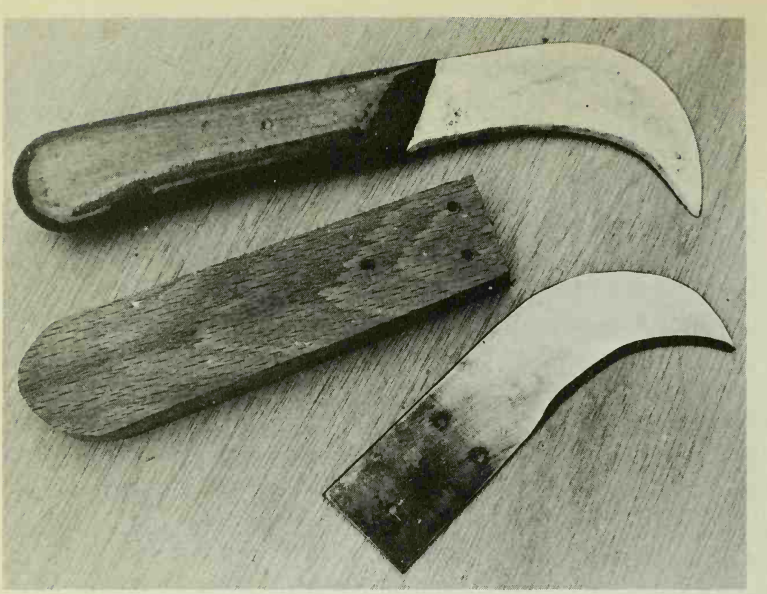


Fig. 9-10. A complete hooked knife and another ready to be assembled.

a good curve to allow it to keep a serviceable shape for as long as possible. Some shape is maintained by grinding away some of the outside curve, as well as sharpening the inside.

The tool is used with a strong pull, which puts a levering action on the handle. The joints should be secured with pins or rivets and epoxy glue.

A tool for scraping paint from shaped parts and for scraping metal for plumber's joints is a shave hook (Fig. 9-12). It has a shaped

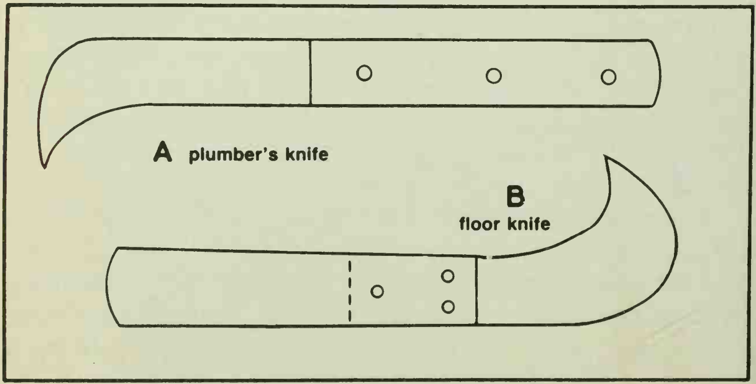


Fig. 9-11. Hooked knives for plumbing and floor covering.

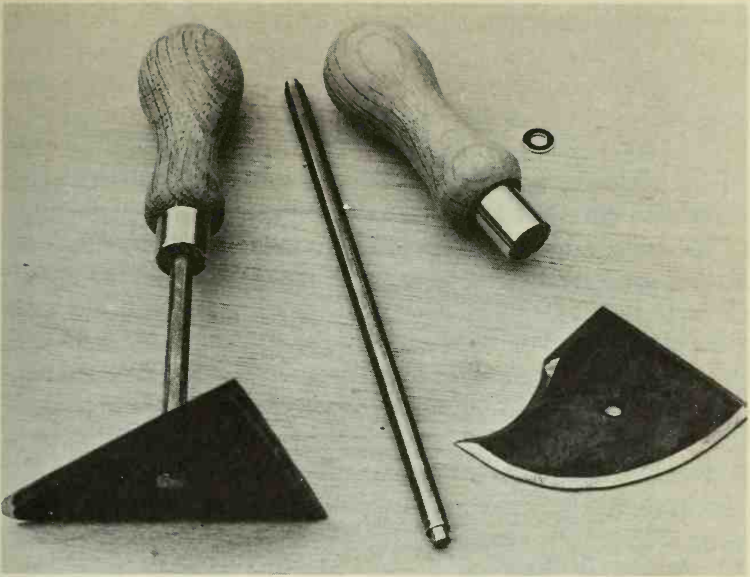


Fig. 9-12. A complete shave hook and another ready to assemble.

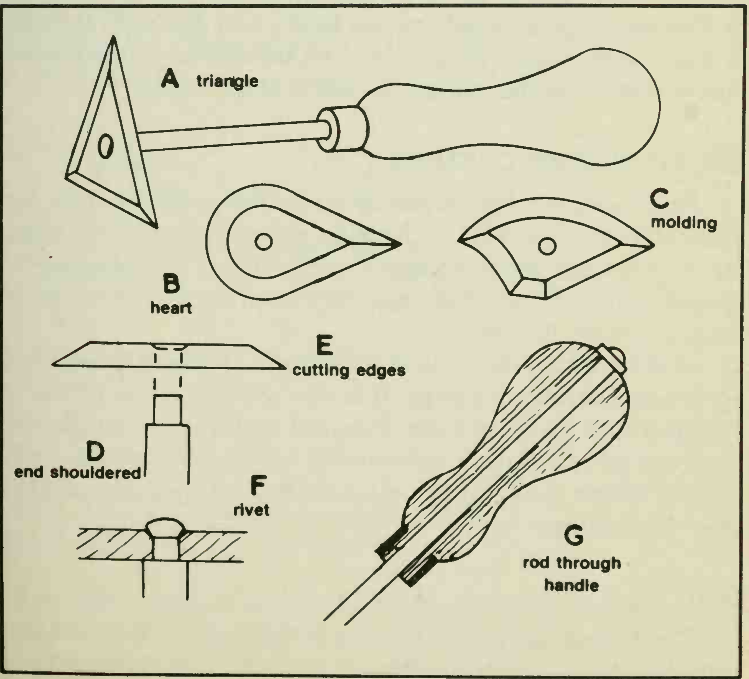


Fig. 9-13. Shave hooks.

plate with cutting edges, attached by a rod to a handle. The basic shape is a triangle (Fig. 9-13A). Other shapes include a heart (Fig. 9-13B) and several combination outlines to follow moldings and other curved sections (Fig. 9-13C).

The steel plate has a hole at the center to attach to the rod. A reasonable size would be a plate up to $\frac{1}{8}$-inch thick and 2 inches across on a $\frac{5}{16}$-inch rod. The rod is shouldered to fit the hole (Fig. 9-13D). Ideally, this would be done on a lathe, but it could be filed because precision is not essential. The rod could be mild steel, but the plate should be tool steel. Grind the cutting edges. The side of the plate toward the handle is kept flat. The other side is ground toward it at about the same angle as a wood chisel (Fig. 9-13E).

Although it might be satisfactory to rely on riveting the rod through the plate, it is advisable to hard solder or braze it as well as rivet it. Lightly rivet the end of the rod, just enough to keep the parts together, but leave gaps to be filled with the spelter or silver solder (Fig. 9-13F). Temper the blade to knife hardness and sharpen the edges on an oilstone.

The shave hook is used with a pulling action. If the rod were merely pointed and driven into a wooden handle, it might pull out. It is better to use a turned wooden handle and drill right through it. The rod then goes through, and its shouldered end is riveted over a washer on the end of the handle (Fig. 9-13G).

BROAD-BLADED CUTTERS

Besides knives that cut mainly with a slicing action, there are some that are used with a chopping action. Others are given a curved edge and are used with a rolling action, or they may be scraped. Most of these tools are wider than knives, and some of them are much thicker.

Making them provides an opportunity to use pieces of steel that are broad, but not very large. It is also possible to use pieces of salvaged steel that may come from leaf springs or large circular saws and to be too thick for ordinary knives. The broader tools needing thinner steel may be cut from discarded crosscut and other large hand saws.

ULU

The Eskimos have a curved knife called an *ulu* (Fig. 9-14A), which is about 6 inches across. It is used for everything from skinning and scraping flesh to preparing meat for cooking and

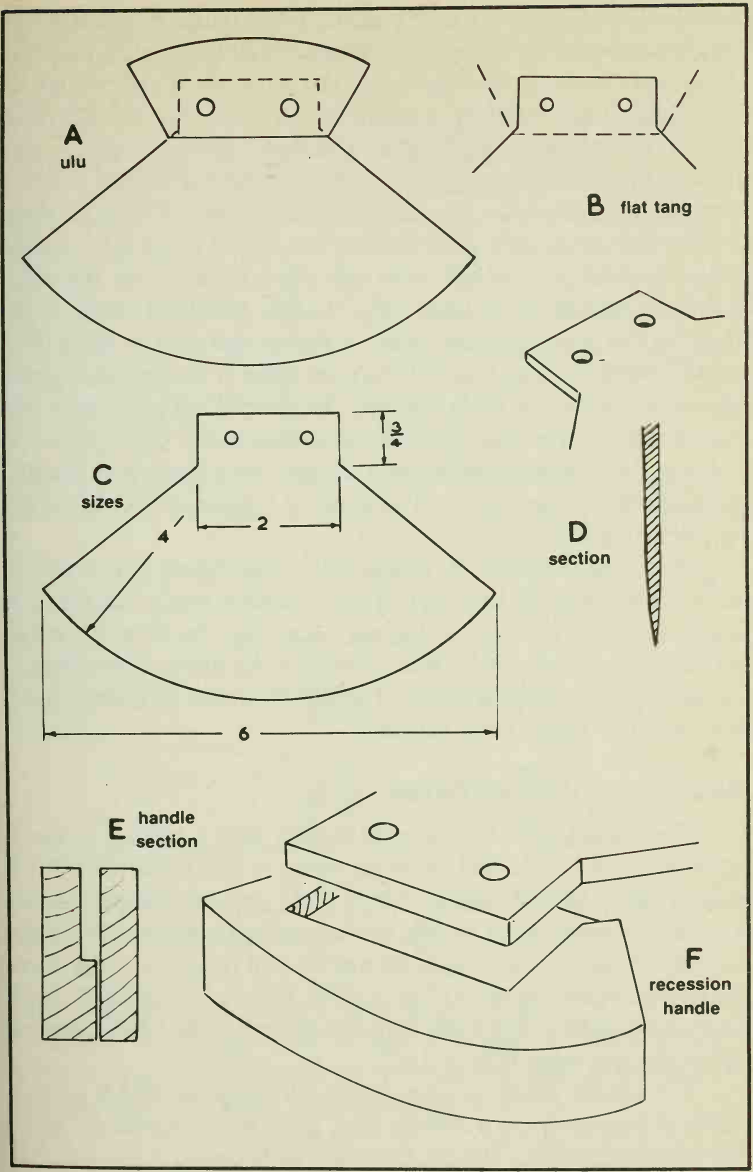


Fig. 9-14. Eskimo ulu.

carving it afterward. They could be used as kitchen chopping and cutting tools or as steak knives on the dining table.

The cutting edge is part of a circle, and the whole knife is slightly more than a quadrant of a circle. It would be possible to make the handle with a full tang and slabs on each side, but the construction shown hides the tang inside the handle (Fig. 9-14B). The steel should be thick enough to be stiff—up to $\frac{1}{8}$ inch would be suitable. Cut it to shape and drill for the rivets (Fig. 9-14C). Keep the full thickness for most of the area but taper to a cutting edge by grinding from about 1 inch back from the curve (Fig. 9-14D). Harden and temper to the usual knife hardness. Polish all over.

So that the handle parts match, it is best if made from a solid piece of wood cut through, with one piece thicker than the other by the thickness of the blade (Fig. 9-14E). Mark the shape of the tang on this piece and cut away so that it will sink in flush (Fig. 9-14F). Mark through and drill the rivet holes in the hollowed piece; then glue the handle parts together. Be careful not to get glue into the recess for the tang. Drill through the second piece, with the holes in the first piece as a guide. Round the edges of the handle, particularly the part that will be over the blade and difficult to get to after attaching to it.

Insert the tang into the handle with some epoxy glue smeared on it. Check that the holes are in line and rivet on the handle. The blade should be polished and given a fine edge for normal cutting, although it can be slightly more obtuse if the ulu is more likely to be used with a chopping action. The handle should be given a finish that will not suffer from washing.

SADDLERS' ROUND KNIFE

The knife that a leatherworker uses with a rolling action is something like a ulu and could be made in the same way, but it usually has a turned handle (Fig. 9-15A), and the cutting edge is a greater length. Most knives are more than a semicircle. Some have a cutting edge that is part of a circle, but others have the curve flattened toward the ends (Fig. 9-15B). The top of the blade could be straight across, but there is better control if the handle is sunk into a sloping edge (Fig. 9-15C).

The handle could be turned specially and should be given a piece of brass tube as a ferrule (Fig. 9-15D). Alternatively, use a file or chisel handle. The blade should be between 5 and 6 inches across. A thickness of $\frac{1}{8}$ inch should provide sufficient stiffness. Sharpen the edge like an ulu, with a taper from about 1 inch back from the curve.

The tang includes a short part that is notched into the handle ferrule about $\frac{1}{4}$ inch. This brings the end of the handle onto a widening part of the blade for stiffness. Cut the end of the handle

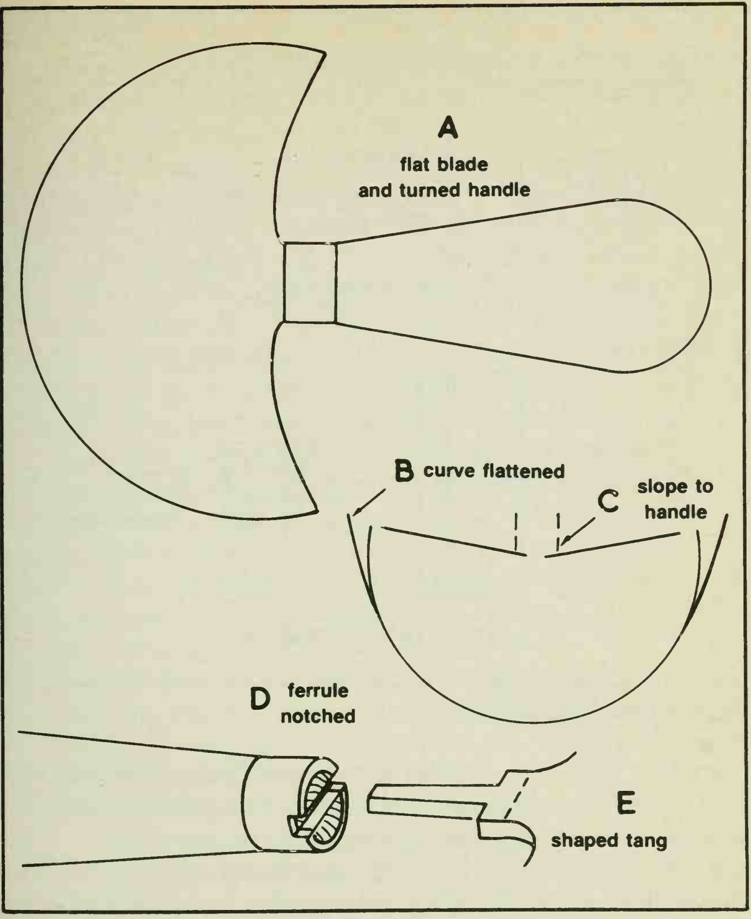


Fig. 9-15. Saddler's round knife.

with a hacksaw and file to a close fit on the blade. The rest of the tang has a slight taper to drive into t hole (Fig. 9-15E). Check that the handle is upright as you drive it onto the tang, while the blade is held tightly between wood packings in a vise.

HERB CHOPPER

Knives of the ulu or saddler's type could be used in a kitchen for cutting on a board, but a two-handed chopper gives better control. Sizes are not critical, but the *herb chopper* shown is about 6 inches long, with a blade just over 1 inch wide (Fig. 9-16A). It looks best with a hollow back, but would work just as well with

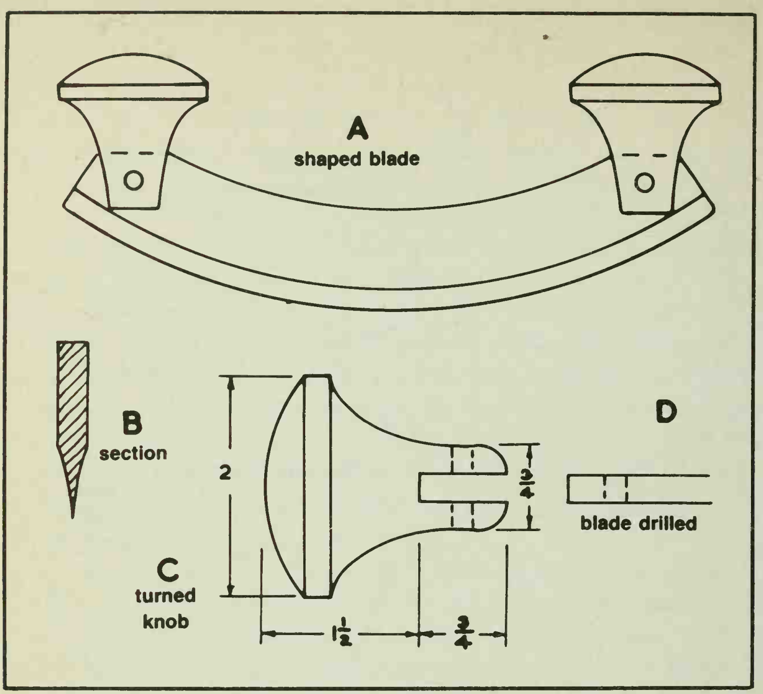


Fig. 9-16. Herb chopper.

a straight back. The handles shown would have to be specially turned, but it would be possible to adapt two matching small tool handles, The broad knobs give a good grip, however.

Although the edge is curved, this should not be much. The curve allows the knife to be rolled from side to side, but for some things it has to be pounded up and down, so a flatter curve gives a broader effective cutting edge when that is done. Cut the blade to shape from $\frac{1}{8}$-inch steel. Round the section of the top edge and round the corners that project outside the handles. Keep the full thickness for most of the width, but taper to the edge from about $\frac{1}{2}$ inch back (Fig. 9-16B).

The handles are fixed with epoxy glue with one rivet through each. Allow for the handles to overlap far enough to give a good bearing surface and drill for the rivets. Clean up the blade and harden and temper it. It looks best if finished to a high polish.

If the handles are turned (Fig. 9-16C), use an attractive close-grained hardwood. Round the lower ends so that they blend into the blade. Saw and file so that they fit closely and the handles are upright on the blade (Fig. 9-16D).

CLEAVERS

The kitchen tool for a swinging cut, where more force is needed than can be applied with the herb chopper, is a chopping knife or *cleaver*. The larger version, used by a butcher to get through bone, is more likely to be called a cleaver. A lighter type is called *chopper*. They are made in the same way. Some weight is an advantage, so steel should be thick in relation to the cleaver size. A cook's knife could be between $\frac{1}{8}$ inch and $\frac{3}{16}$ inch thick; a butcher's cleaver would be $\frac{1}{4}$ inch or more. Lengths, in both cases, could be between 9 and 12 inches, with about 4 $\frac{1}{2}$ inches of that in the handle. Blade depth may be no more than 2 inches in the smallest cook's knife, but the weight required in a cleaver comes from increasing the depth to about 4 inches. Suitable proportions are shown (Fig. 9-17A).

The back and end could be straight and at right angles to each other, but the shape is more attractive if the back is slightly hollow and blends into a down-turned handle (Fig. 9-17B) while the end sweeps out to a slightly longer cutting edge (Fig. 9-17C). A butcher's cleaver has a hole for hanging with the corner rounded (Fig. 9-16D), but this is not common in a lighter cook's knife.

The end of the blade should curve into the line of the handle, which should be a full tang type to withstand the shock of making chopping cuts (Fig. 9-17E). It may be a plain handle, or there may be a bolster. In any case, it is fixed with glue and rivets or pins like normal knife handles.

A butcher's cleaver is used like a hatchet on hard bones, so a fine edge would not last long. The last inch is thinned, but the cross-section is a curved taper (Fig. 9-17F). A small cook's knife has a dual function. It may be swung, but much of its cutting is likely to be done with an action similar to that used with the chief's knife, levering it onto the food being cut. If this is to be its main action, the edge could be hollowground (Fig. 9-17G). For slightly heavier treatment there could be a straight taper. For regular swinging cuts it should have a similar section to a cleaver.

Temper slightly softer than for a cutting knife. Go well into the brown oxide color to give toughness at the expense of slight hardness.

HATCHET

The usual small hatchet or ax with a hole for the handle through the head cannot be made with knifemaking equipment, but it is possible to use a construction like a cleaver to form a serviceable

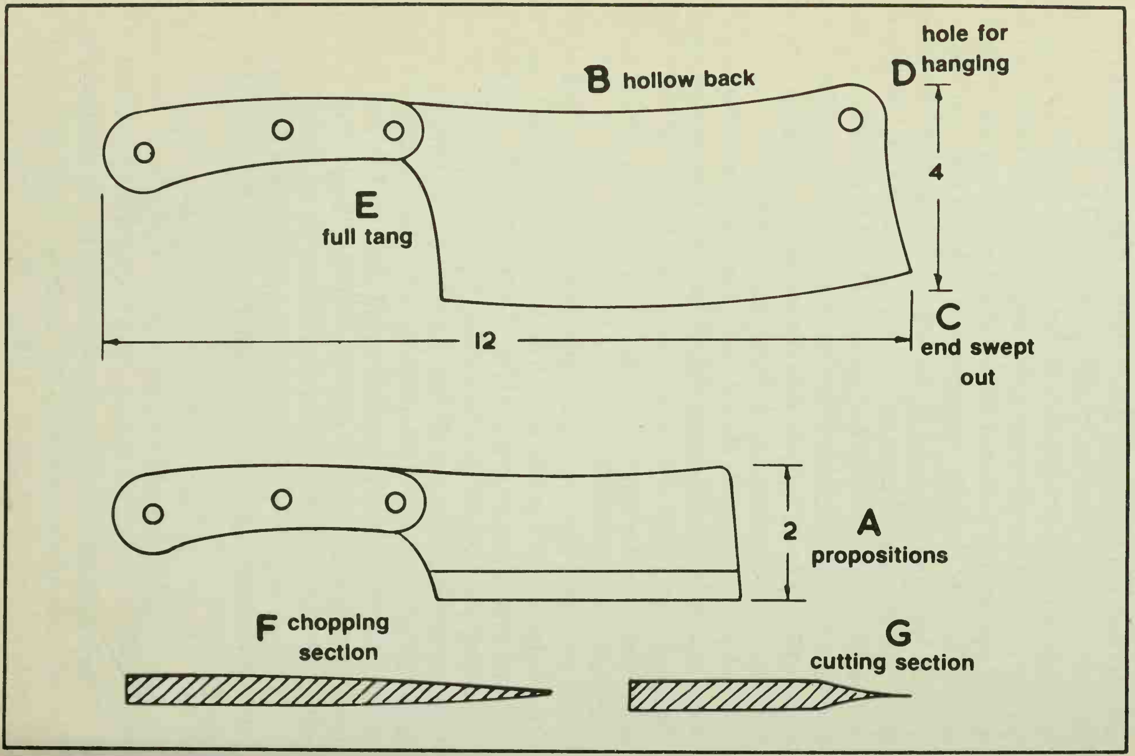


Fig. 9-17. Cleavers.

small *hatchet* (Fig. 9-18A). Balance is somewhat different because the steel is being carried back into the handle, but for its size, such a hatchet should work with more precision than a comparable conventional hatchet.

With the amount of steel providing weight in the tool, the hatchet could be made from $\frac{1}{8}$-inch or $\frac{3}{16}$-inch steel. A slight dog-leg curve in the handle part improves appearance (Fig. 9-18B). The end of the handle should be given a definite *swell* so that there is no risk of the hatchet flying from the hand during a swing (Fig. 9-18C).

This could be done with steel full tang, or the wood could be carried farther to provide the shaping, possibly in the width as well as the depth. Use a solid piece of wood. Cut it to the handle profile.

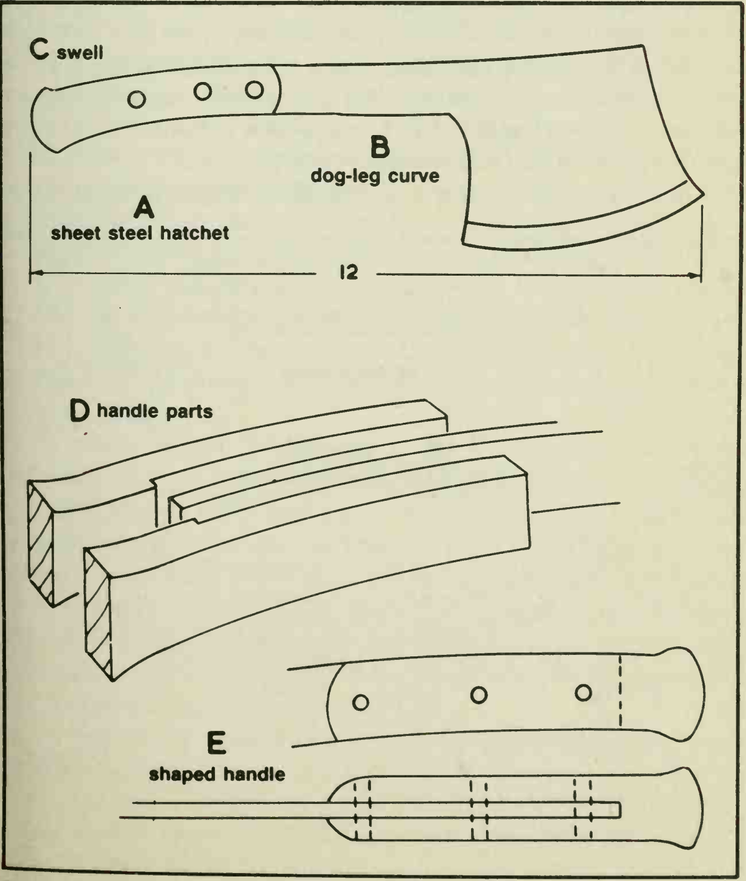


Fig. 9-18. Hatchet.

Then divide it down the middle and further cut out each piece to take the tang (Fig. 9-18D). The extending piece will be glued later. Thin the main part of the handle and shape the swell (Fig. 9-18E). Prepare the rest of the handle for attaching to the tang in the usu way. Leave final shaping and sanding until after assembly, but and rivet the parts together with clamps until set. A hatchet h is best left with a well-sanded surface without an applied polis other finish. It could be oiled, but it will soon acquire a luster from handling.

DRAW KNIVES

A straight knife blade between two handles that is intended for pulling is called a *draw knife* or a *drawing knife*. If it has a curved blade, it may be called a *scorp*. Coopers used many variations of these in making wooden barrels, and the basic types still have uses in outdoor woodwork and doing such work as shaping seats. Tools of the normal type are forged, but it is possible to make simpler versions that work quite well. Construction is something like the herb chopper, with the handles reversed.

A straight draw knife is a parallel piece of steel between 6 and

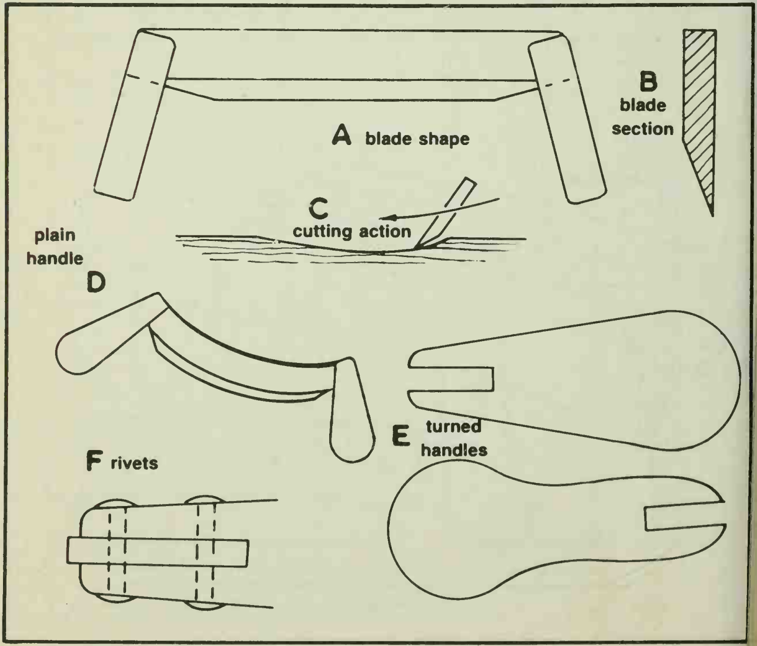


Fig. 9-19. Draw knives.

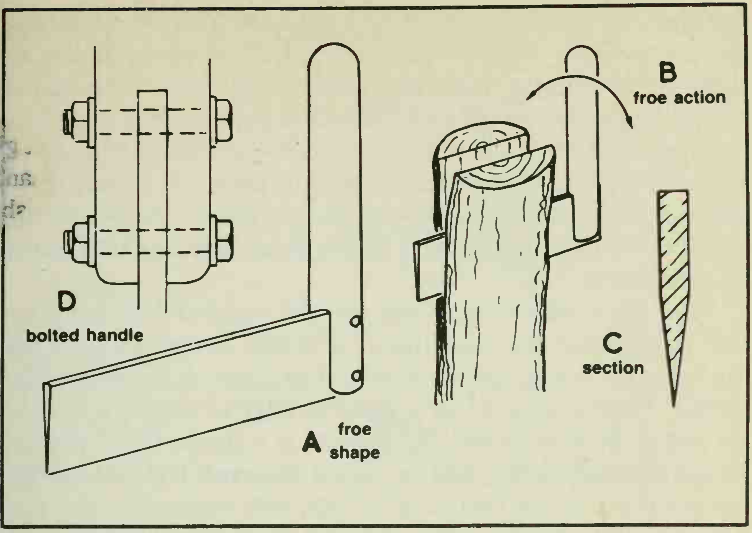


Fig. 9-20. Froe.

12 inches long and about 1 $\frac{1}{2}$ inches wide. The thickness should be enough to provide rigidity. The smallest knife could be $\frac{1}{8}$ inch thick, but larger ones would be up to $\frac{1}{4}$ inch. The ends are ground back so that the handles are attached at a slight angle (Fig. 9-19A).

A draw knife has a chisel cross-section (Fig. 9-19B). It is used with the flat side downward for a deepening cut or with the bevel downward for scooping hollows (Fig. 9-19C). Grind a flat bevel, which will be brought to a cutting edge with an oilstone after the tool is completed.

The simplest handles are pieces of round hardwood (Fig. 9-19D), but it is better to have turned handles with enlarged ends to pull against when making a cut (Fig. 9-19E). They are slotted to fit over the steel and may go the full width. Only one rivet in each handle for a small knife should be satisfactory if epoxy glue is used also. A wider blade can have second rivets to take heavier loads (Fig. 9-19F). Let the handles be long enough and the ground ends of the blade sufficient to keep knuckles away from the cutting edge.

Scorps are made with curves varying from shallow curves to quite tight semicircles. Salvaged steel from a leaf spring may already have a satisfactory curve. Otherwise, flat steel can be forged to a suitable shape. Except for the curve, the method of construction is the same as the draw knife.

Another older tool in the same family is a *froe*. This was the standard tool for splitting or cleaving wood and is still very effective for that purpose in such tasks as preparing wood for fences or making roof shingles. There is a broad straight blade and a handle at right angles at one end (Fig. 9-20A). A cut is started by hitting the blade into end grain with a rough mallet. Then the handle is levered backward and forward to make the blade split its way along the grain (Fig. 9-20B). Size depends on the purpose, but for average use a blade 2 by 10 inches and a handle about 12 inches long should be satisfactory.

The blade has to cut its way into the wood at first, but after that its action is more like that of a wedge. It may keep its full thickness for about half its width, then taper to the edge (Fig. 9-20C). There is no need for a knifelike edge as long as it will enter end grain when driven. The handle is a simple round rod, although a turned handle could be made if preferred. It should overlap the full width of the blade and be held with two nuts, bolts, and washers. The levering action is better resisted by bolts through washers than by rivets, and they allow easy replacement if the handle breaks or becomes worn (Fig. 9-20D).

Smaller and lighter versions of both draw knife and froe are used in some types of basketmaking (Fig. 9-21). Blades are only about 4 inches by 1 inch. They may be finished with polished surfaces and varnished handles, more appropriate to this more delicate work.

CHISELS

Several woodworking cutting tools are related to knives and

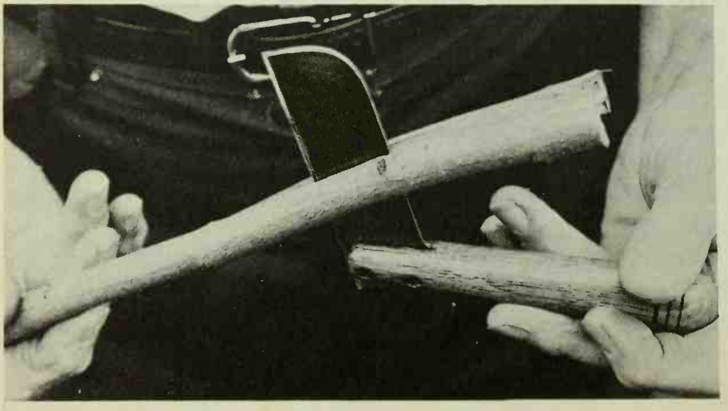


Fig. 9-21. A small basketmaking froe for splitting twigs.

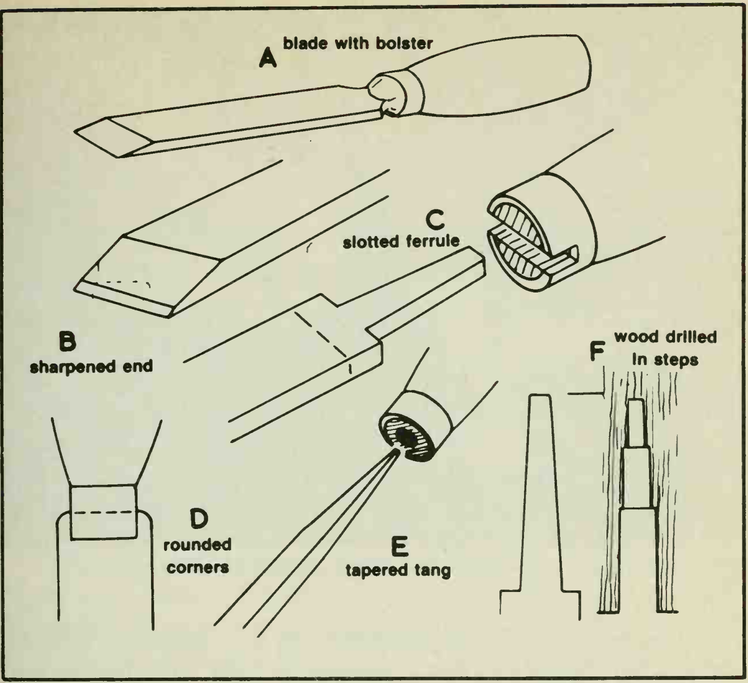


Fig. 9-22. Chisels.

can be made in similar ways. There are many variations on chisel design, and making some of these tools can provide an extension to a carpenter's tool kit at little or no cost. The blade of a manufactured chisel is normally fixed into a handle with a tang, and a bolster prevents it from going further in if the handle is hit with a mallet (Fig. 9-22A). This type of construction is difficult to produce by hand, as it involves forging, but there are alternative ways of making satisfactory chisels. Not all chisels have to be made to withstand hitting (Fig. 9-23). Those used for paring and turning are never hit, so a forged bolster is not needed. Light carving tools are not hit. There are chisel-like tools used on leather—as in making sheaths—that are not hit.

Many modern, professionally-made chisels have plastic handles molded onto the tangs, but it is better to follow traditional practice and use wooden handles with metal tube ferrules. Handles may be bought or turned if the knifemaker has access to a lathe. Handles intended for other tools may be adapted. Handles need to be round. An octagonal handle gives a good grip and will not roll off the bench. Its end can be whittled to fit a tubular ferrule.

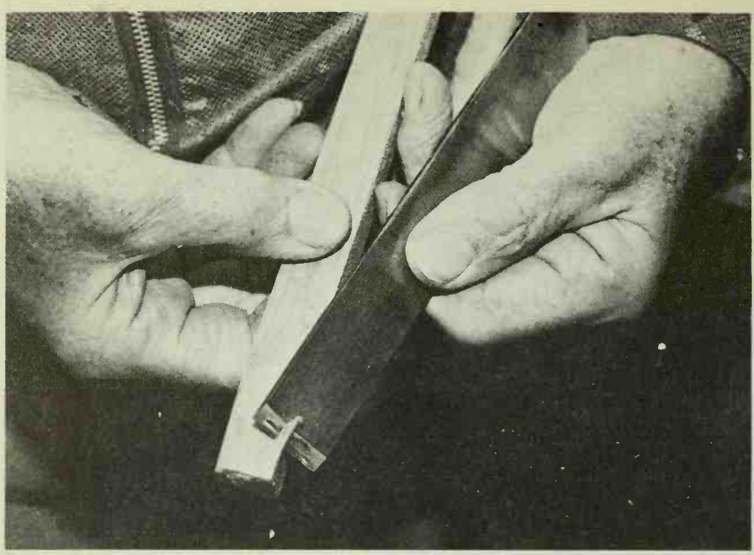


Fig. 9-23. A light unhandled wood chisel suitable for whittling.

A basic chisel is a flat piece of steel. It is important that that back of the chisel be as flat as possible, at least an inch or so from the cutting edge. If salvaged steel is used, that surface must be ground flat. Any pitting from rust that goes too deep to be ground away would make the steel unsuitable for a chisel; a good cutting edge cannot be made if the surface is uneven due to rust. The surface of a chosen piece of steel should be prepared before going any farther with making a chisel because it would be wasting time to do other work if a good flat back could not be made. Flatten on a belt sander and follow by rubbing with a circular motion on an oilstone.

Edges are ground at right angles to the back. The cutting edge is ground at about 25°. Later sharpening on an oilstone will be at about 35° (Fig. 9-22B), but the blade should be finished and mounted in its handle before this is done.

A paring chisel might be given a tang to drive directly into a hole in the handle, but it is better to let the full width of the blade into a slot in the ferrule (Fig. 9-22C). If possible, make the blade and ferrule the same width. If the blade is wider, round the exposed corners (Fig. 9-22D). If it is a narrow chisel, such as a piece of $\frac{1}{4}$-inch square steel, it can be given a slight taper and be driven directly into a slightly undersize hole (Fig. 9-22E). For any size chisel, the tang should go about 2 inches into the handle.

Drill the handle almost as deep as the tang will go; otherwise, there is a risk of splitting. Use two or three different size drills to allow for a tapered tang (Fig. 9-22F). How much the holes are undersize depends on the wood. Very close-grained wood and hardwood will have to be almost full size. Softer wood may have smaller holes. Some of the hard plastics can be softened in hot water or by a little more heat in an oven so that they become quite pliable. If a handle is made from one of these, the hole is made undersize and then driven on while soft from heating. The plastic then shrinks on and makes a bond that probably cannot be released without breaking the handle.

Wood chisels should be tempered to about the same temperature as a knife. There is no need for a high finish on the blade, but it should be ground true and finished on a belt with fine abrasive, except for the back being further rubbed on an oilstone. Wood chisels are needed in all widths and lengths, so any size steel of square or rectangular section can be used.

For most hand paring there is an advantage in giving the chisel a bevel edge. Because it is ground not quite to a sharp edge, it allows the chisel to be used close into an acute corner (Fig. 9-24A). The bevel can be taken to a shoulder (Fig. 9-24B) or be angled back from the end (Fig. 9-24C). Chisels are usually made parallel, but there is no need to grind a tapered piece parallel. Many older chisels were wider at the cutting edge than further back (Fig. 9-24D). This is an advantage in some carved work. A very wide tapered chisel (Fig. 9-20E) is almost an end-cutting knife, which can be used for paring leather.

Most chisels are sharpened square across the end, but there is sometimes a need for a skew chisel (Fig. 9-24F). A pair can be made with opposite corners leading. Some skew chisels for caving are reduced in width to give clearance behind the cutting edge (Fig. 9-24G).

Wood turning in average sizes is done with fairly substantial tools. Smaller versions can be made for model lathes, but there is too much vibration if light-sectioned tools are used on a larger lathe. Even on bought turning tools there is no bolster, so any made by an amateur can be given a tapered tang to go directly into a hole in the handle (Fig. 9-25). Length is needed for leverage (Figs. 9-27 and 9-28), so both blade and handle are long (Fig. 9-26A). Chisels should not be less than $\frac{1}{16}$ inch thick and may be used to $\frac{3}{8}$ inch whatever the width. Widths are between $\frac{1}{4}$ and $1\frac{1}{2}$ inches. A turning chisel differs from other chisels in being sharpened on both sides

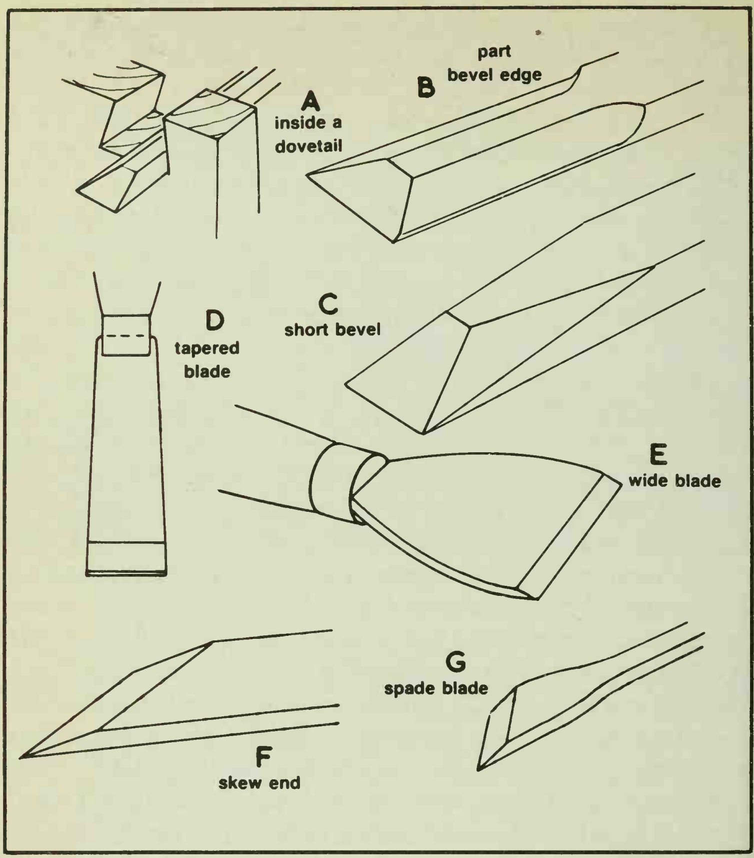


Fig. 9-24. Bevel edge and special chisels.

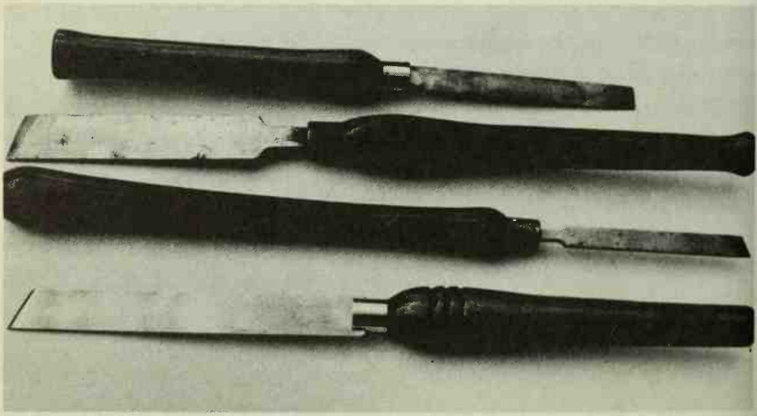


Fig. 9-25. Turning chisels with long handles to provide leverage.

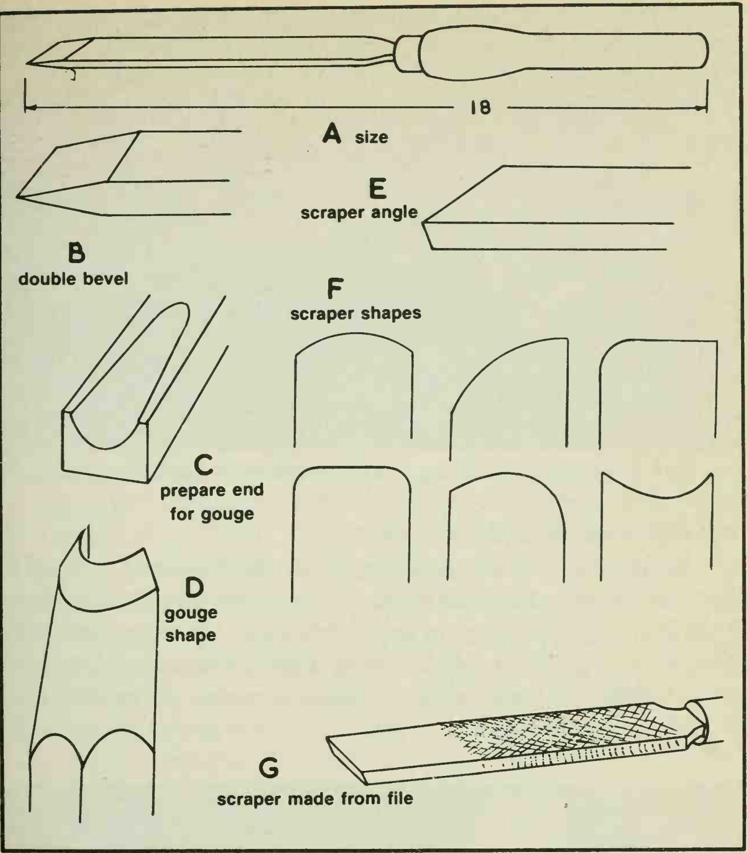


Fig. 9-26. Wood-turning chisel, gouge, and scrapers.

of its skew end (Fig. 9-26B). It may be a long straight bevel on each side but some turners favor rounding the bevel to blend into the flat parts.

Gouges needed for turning would be difficult to forge in the normal patterns, but the end of a solid rod could be ground to shape. As the tool shortens because of resharpening, the hollow would have to be reground occasionally. The hollow could be filed on annealed steel or ground with a suitable wheel. It should be deep enough to almost make a semicircle (Fig. 9-26C). The outside is ground to make a cutting angle up to it. The back of the tool that will go on the lathe tool rest should be rounded so that the tool can be rolled. Farther back it can remain square or flat (Fig. 9-26D). The end of a gouge may be sharpened straight across for roughing wood to shape, but for shaping there is an advantage in a *spindle nose,* where

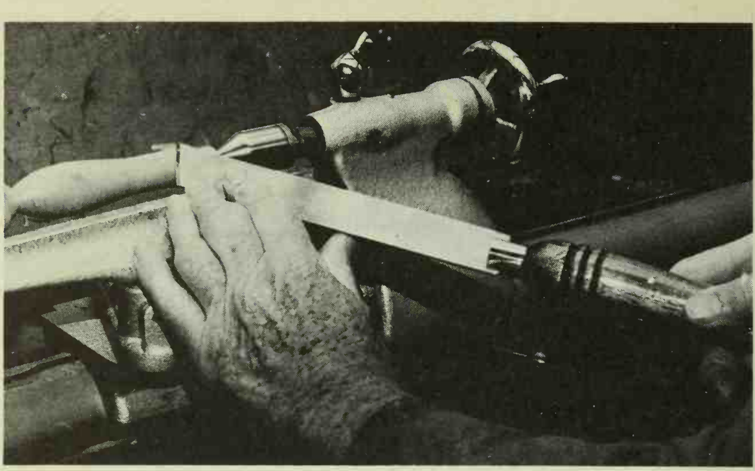


Fig. 9-27. A turning chisel being used to shape a file handle on a lathe.

the end is rounded like a finger nail.

Some cutting in wood turning has to be done with a scraping action. Scrapers should be strong but need not be very long. Steel $\frac{1}{4}$ inch or more thick and in any width up to $1\frac{1}{2}$ inches should be ground with a flat top and a cutting angle giving about 15° relief (Fig. 9-26E). Various profiles besides straight are needed (Fig. 9-26F).

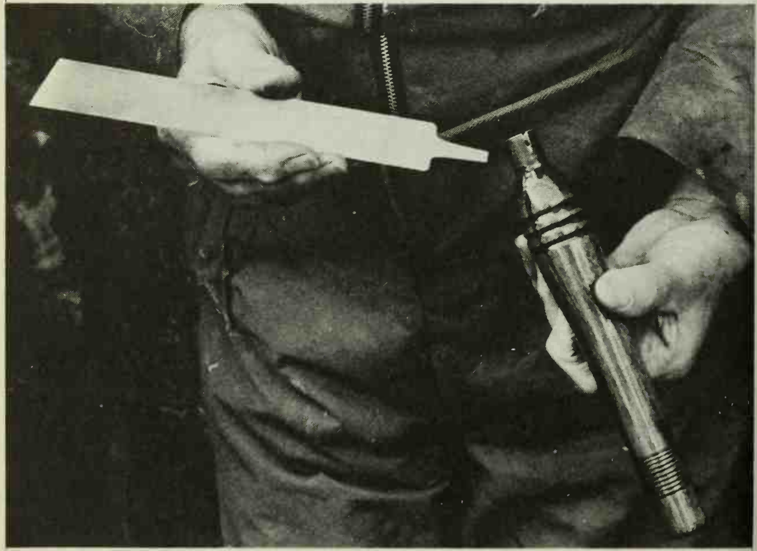


Fig. 9-28. This turning chisel fits into a notched ferrule for extra strength.

Old files can be made into turning scraping tools. Teeth are ground away from the top, and a cutting angle is ground on the end (Fig. 9-26G). Any other grinding need be no more than is needed to dull the teeth where they will be handled. Files are tempered very hard. This makes them brittle, so it would be unwise to use light-sectioned files for heavy turning because they would snap. Large files are often made into turning scrapers and used without further heat-treatment, but it is wiser to reharden and temper to no more than a dark straw color so that there will be less risk of breakage when attempting heavy cuts.

Round steel rod can be made into chisels. The flat back surface is made by grinding diagonally; the shapening angle is then ground at the correct angle in relation to it (Fig. 9-29A). This type of chisel is useful for work in hollows as when leveling grooves or cutting the background of a carved panel.

One type of chisel that can be hit with a hammer is made without a handle (Fig. 9-29B). The upper part has the sharpness taken off the corners for a comfortable grip, and a bevel is ground around the top to limit its spreading under hammer blows. The cutting end should be tempered to a brown color, but the top should be left soft.

If a chisel with a handle is intended to withstand hitting, it should have a bolster, which ought to be brazed on as silver solder might not be strong enough. It should be wider than a bolster on a knife and tapered to the blade. The large end looks best if it is rounded to match the ferrule, or it can be ground octagonal (Fig. 9-29C).

Although a chisel may be expected to eventually be ground right back to near the handle during a long life, it is probably better

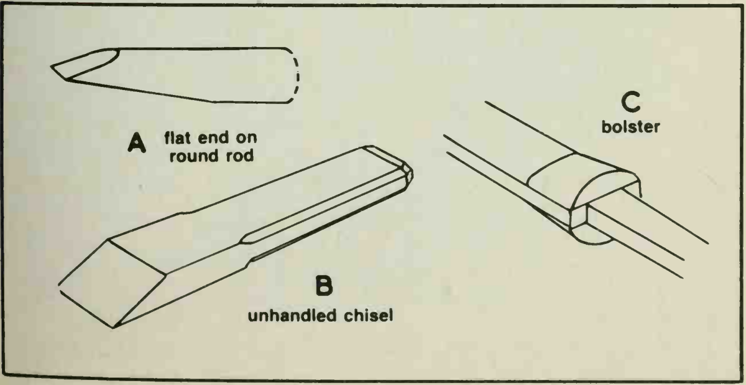


Fig. 9-29. Special chisels without handles and with bolsters.

in heat-treating to deal with the end for only an inch or so, while leaving the steel soft further back. Then the body of the tool will be tough. If the end ever does become ground farther back than it was tempered, the new end can be heat-treated afresh.

TROWELS

Trowels used for plaster and concrete have tempered steel blades and cranked tangs into wooden handles. The tangs can be joined to the blades by brazing or hard soldering. For smaller trowels they can be shaped without difficult forging. There are many shapes and sizes of trowel, but the method of assembly is the same.

For a small trowel (Fig. 9-30) the tang can be a piece of round or square mild steel, $\frac{1}{4}$ or $\frac{3}{8}$ inch thick. There is no need to use tool steel for this part. File or grind a square point on one end of the rod before cutting it (Fig. 9-31A). The point could be drawn down by hammering after heating to redness and pulled around (Fig. 9-31B) before the cold vise has drawn the heat away. Make a second bend so that the tang will be about 30° to the base (Fig. 9-31C). Cut the tang from the rod. Hold the pointed end with tongs or grips while heating the other end to redness. Hammer it thin and flat on an anvil or iron block (Fig. 9-31D). As mild steel is unaffected by heat, it can be quenched in water.

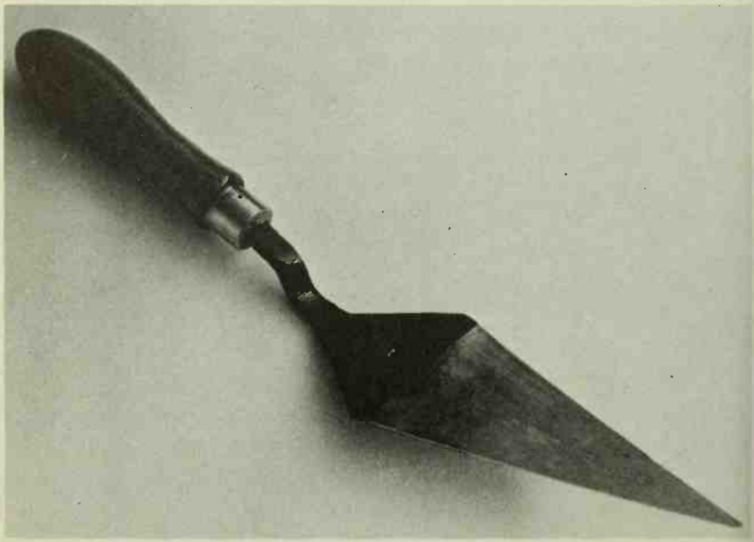


Fig. 9-30. A small plastering trowel.

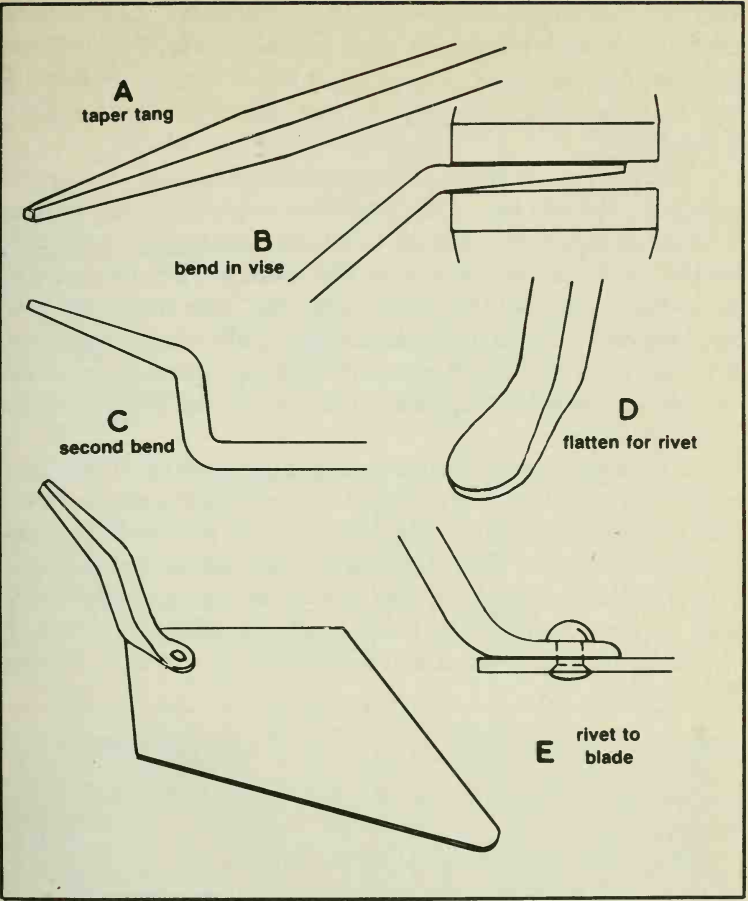


Fig. 9-31. Shaping the tang of a trowel.

File or grind the underside flat and brighten around the edges of the flattened end. Although the bottom should be mainly flat, the edges can have a slight bevel to allow the spelter or hard solder to enter the joint. Drill the flattened tang and the blade for a rivet, which could be a piece of iron rod. It is less trouble to use a round-head rivet, with its prepared head on top. Lightly countersink the hole under the blade. Make sure all the meeting surfaces are clean. They could be smeared with flux before being brought together. Lightly rivet the parts (Fig. 9-31E). There is no need to make a very close fit with the countersunk rivet head nor to hammer it level. Gaps will fill with spelter or hard solder, and any projecting head can be ground level afterward (Fig. 9-32).

Whether the joint is made before or after hardening and tempering the blade, depends on whether spelter or high temperature hard solder is used (when heat-treatment must follow making the joint) or low temperature silver solder (which can be used after heat-treatment).

Handles may be adapted from other tool handles. If a handle is turned, it should have a ferrule and be of sufficient size to offer a comfortable firm grip. Blades vary in thickness according to size, but they are from less than $\frac{1}{16}$ inch thick upward. They are tempered to nearly blue so that they are flexible, but there may have to be some experiment with particular steels to find the best heat to use. For most purposes the blade can be uniform thickness, but some are thinned toward the edges and point so that the center remains a little stiffer.

A *pointing trowel* is diamond shaped and pointed. It may be 3 to 8 inches long (Fig. 9-33A). Another small tool is a *margin trowel* (Fig. 9-33B) with a rectangular blade about 4 by 2 inches. A *tuck pointer* or *joint filler* (Fig. 9-33C) is a similar shape, but the blade is long and narrow, and the tang lifts the handle to a higher angle than on other trowels. The blade could be 6 inches by $\frac{1}{2}$ inch. It should be tapered in thickness toward the tip so that it is more flexible there.

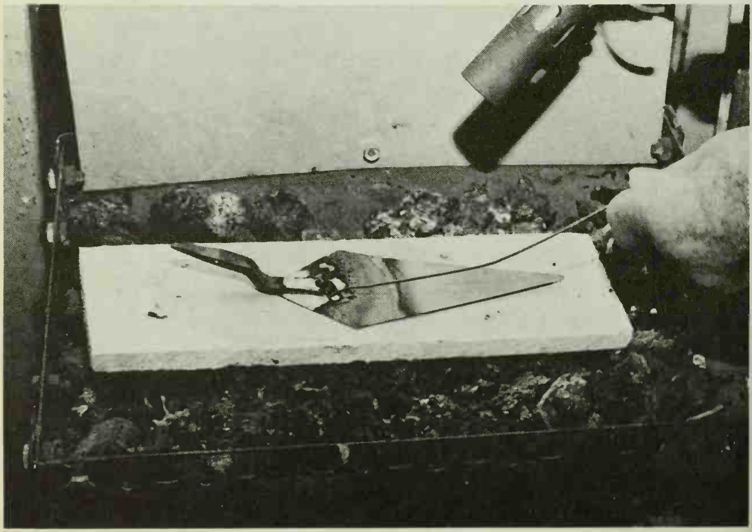


Fig. 9-32. Hard soldering the tang to the blade of a trowel, which is supported on an asbestos block.

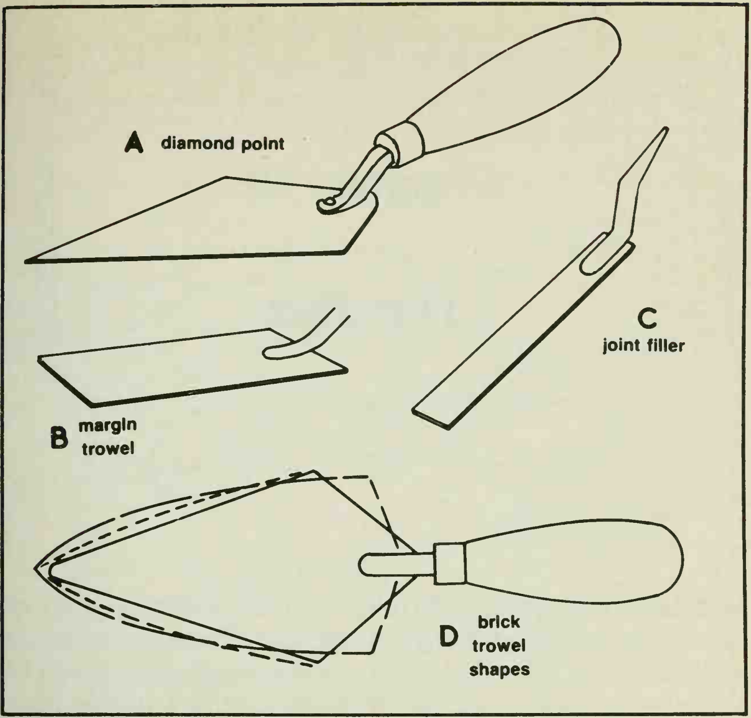
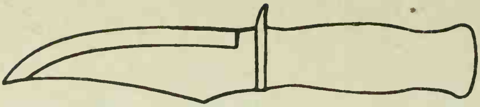


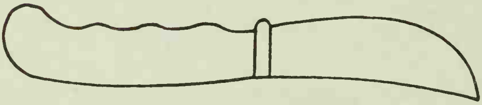
Fig. 9-33. Various shapes of plasterer's and bricklayer's trowels.

Ordinary brick trowels vary slightly and are given special names, but the shape is basically like a pointing trowel with a rounded point. Sizes are larger, with lengths from 9 to 13 inches (Fig. 9-33D).



Chapter 10

Handles



Most individually made knife handles are either slabs or scales on full tangs or solid pieces of wood on half tangs. These are convenient ways of making attractive and serviceable handles and should be chosen when there is no special reason for using another type. Those handles, and some variations of them, have been described in earlier chapters, but the handles described in this chapter provide ideas for making knives handled in other ways. One attraction of making your own knives is that you can produce individual specimens that have a character and quality of their own. It is in the handle as much as the blade that a knife can be given individuality.

ENCLOSED TANG

A full or half tang exposed on the edges of the handle certainly provides evidence of how far it goes and the strength of the handle, but a line of steel around a polished wood handle may not be regarded as pleasing in appearance. The shape of the handle is limited by the shape of the steel. If the handle is to be wider than the blade or curved so that there is much work in shaping the steel of a full-tang handle to conform to the shape, steel will be wasted. Such a handle also is hard work if shaping is done by hand or time consuming if the shape is flame-cut and ground. Another way of dealing with the handle is to use what is almost a full tang, but to build the handle around it.

The tang is cut down in relation to the blade width and can be parallel or slightly tapered. It is drilled in the usual way (Fig. 10-1A). Slabs are cut to the intended outlines, larger than the tang. The shape of the tang is marked on one slab, and pieces of wood

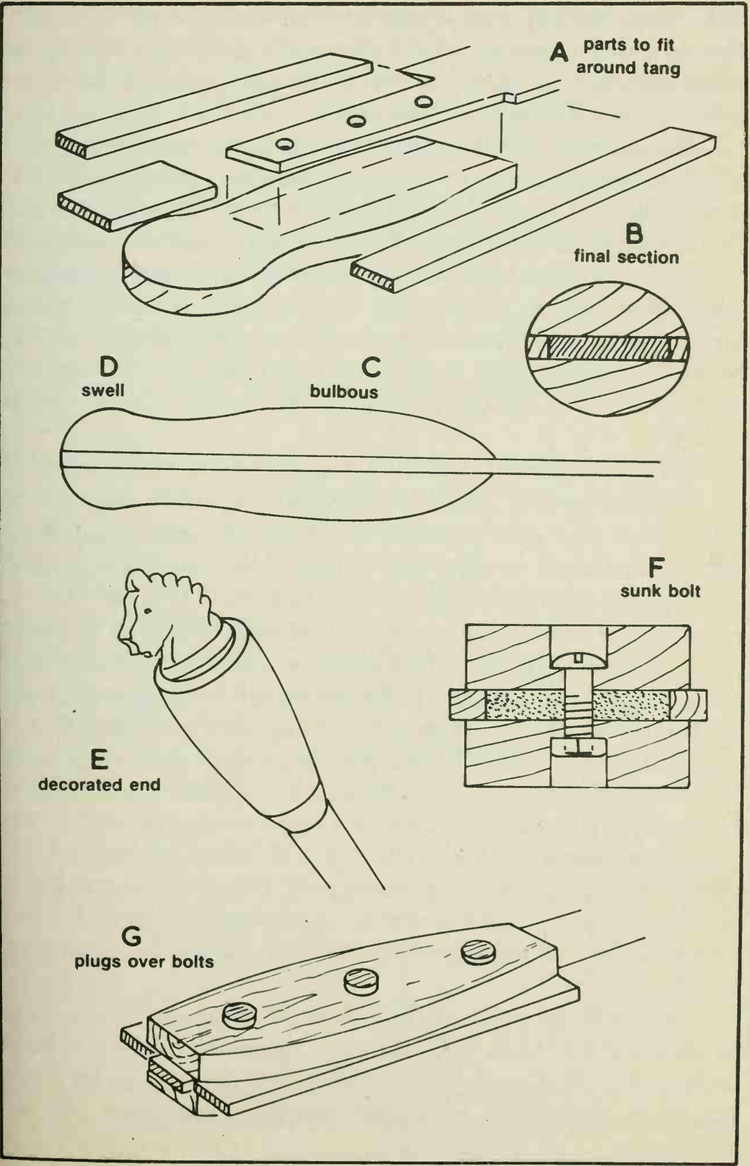


Fig. 10-1. Steps in making an enclosed-tang handle.

slightly thicker than the tang are glued on (Fig. 10-1B). The outer edges may be left oversize for trimming later. When the glue has set, plane or sand these pieces down to the thickness of the tang. The number of pieces depends on the design. If there is to be much handle at the end past the tang, it may be best to cut from one piece. Otherwise, build up with two or three pieces, but have their grain the same way as that of the slab. Normally, the wood would be the same, but an interesting pattern can be made by using wood of a contrasting color for the filler pieces.

Further assembly is to glue and rivet or pin the parts together and then shape the outside. Most straightforward handles with slabs are curved in their width but straight in their length. Building up the handle around the tang allows shaping in both directions. A handle fits the hand better and makes a safer and more comfortable grip if it is bulbous (Fig. 10-1C). This could be combined with a swelling at the end to prevent the hand from sliding off (Fig. 10-1D). When the handle is built out from the tang all around, the only limit to shaping is the need to avoid going so deeply that the steel is exposed.

Anyone interested in carving may wish to decorate the end of an enclosed handle. An elaborately carved handle may not be appropriate on a knife intended for heavy use, but a paper knife for use on a desk, or other lightly used tools, could have a head, chess piece, or other design carved on the end (Fig. 10-1E).

Exposed pins or rivets may not be appropriate on a shaped enclosed handle. These can be avoided by using small nuts and bolts counterbored and plugged. The plugs should be of the same wood as the handle, with the grain across. Plug cutters available for use in a drill press provide the best way to produce plugs from scrap wood left from cutting slabs. Choose a size slightly larger than the bolt head or nut. Have a head with a screwdriver slot. Drill for the plugs deep enough to leave about $\frac{1}{8}$ inch above the head or nut. Then drill through for the screwed part. Cut off the screwed part so that it will go into the nut but not project through it when tightened. A trial assembly will show how much to cut off (Fig. 10-1F).

Assemble the handle with glue and the nuts and bolts. Glue in the plugs with their grain the same way as the slabs. Let them project (Fig. 10-1G) to be brought level after the glue has set. Then the whole handle can be shaped without metal being exposed anywhere.

TURNED HANDLES

If a lathe is available, handles for many tools can be turned. Round handles are appropriate to chisels and other end-cutting tools. They can be given octagonal parts if a grip is needed to turn the handle, like a screwdriver. This also prevents a narrow tool from rolling off the bench. Some knives may be given round handles, but for most purposes it is better to have a handle section that is deeper than it is wide. Such a handle gives directional control and prevents the knife from turning in the hand.

A round knife handle can be made like a half-tang handle: first turned to shape completely then sawn to accept the tang (Fig. 10-2A). If there is much shaping to a turned handle, the tang would have to be shaped to match, so it is more common to keep that part straight (Figs. 10-3 and 10-4).

A plain round handle may be smoother than is desirable for a good grip. One way of improving the grip without altering the

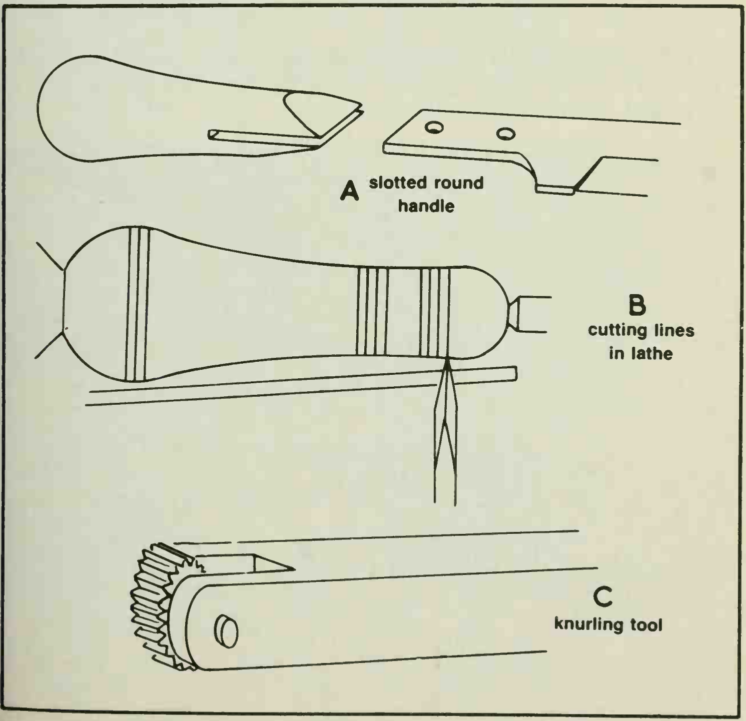


Fig. 10-2. Turned handle for a half tang. Rings around and lines from a notched wheel aid grip.

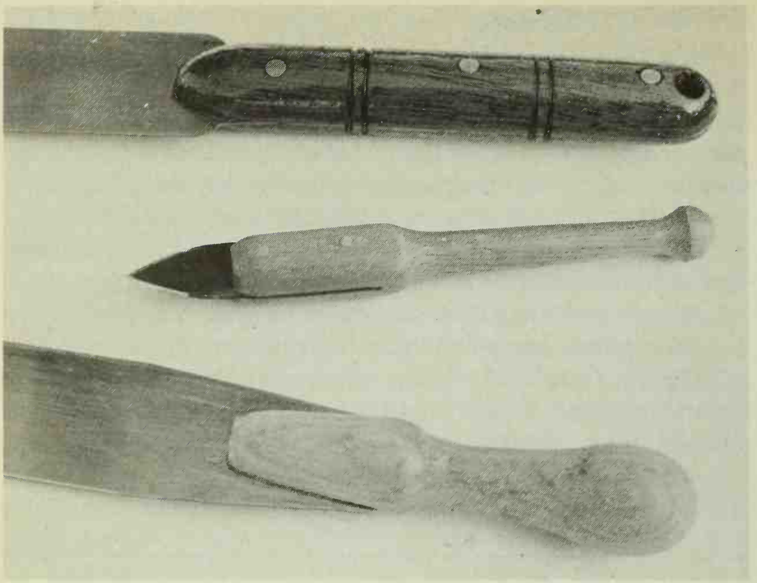


Fig. 10-3. Turned handles. The long parallel one has been turned and cut along the middle to make slabs. The other two are half tang with the blades glued and pinned.

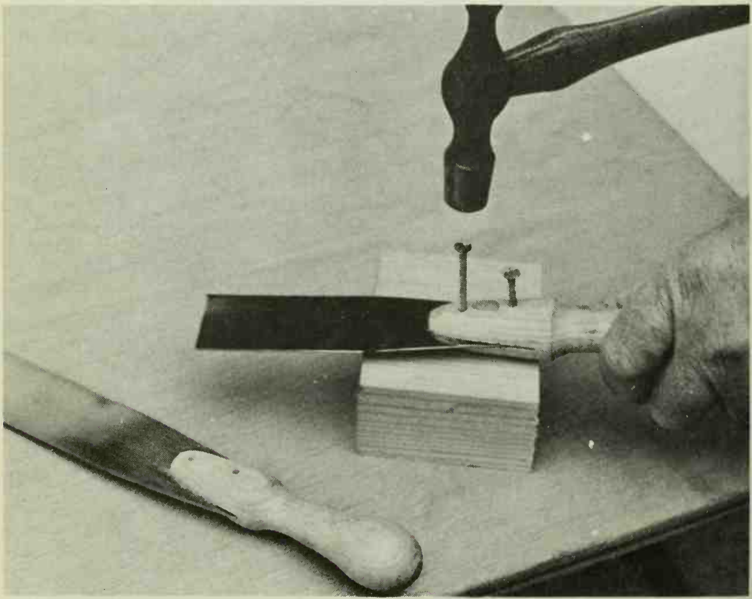


Fig. 10-4. Ordinary nails can be used as pins, driven through and cut off then filed level with the wood.

shape is to use the long point of a turning chisel to cut closely-spaced lines around the wood while it is revolving in the lathe (Fig. 10-2B). Having these lines in groups could also be regarded as decoration. Another treatment is to use an engineer's *knurling tool*, which is a hard patterned wheel that is intended to be thrust against revolving metal to produce a grip, but it will also work on wood. A similar tool could be improvised by using a small pinion or cog on a nail through the slotted end of a piece of wood (Fig. 10-2C). Move this along the tool rest while the wood is revolving. It will make lengthwise dents that could be combined with cuts around the wood to make a grip between plain ends.

The traditional knife used by mount cutters, who cut card and veneer to make picture mounts, was a hollow handle with a blade sliding through it. A similar idea could be used for any knife intended for light trimming. As the steel is worn by sharpening, more can be brought out. The adjustment also allows varying the blade length as required.

To make a handle with a rectangular slot through it, the wood is prepared for turning by gluing strips together (Fig. 10-5A). The slot should be a sliding fit on the piece of steel being used for the knife. Have the wood longer than the final handle will be. Temporary plugs can be pushed in the ends to provide locations for the lathe centers. The glued block should be square. It will help in shaping in the lathe if the corners are planed off (Fig. 10-5B).

The ferrule should be a piece of thick-walled tube. The thickness is needed as it has to be threaded to take a securing screw (Fig. 10-5C). When the handle is completed, a hole can be taken right through and a thread cut all the way, although the screw only enters one side. Doing it in this way allows the tap to cut a good thread and gives an alternative setting for the screw if the first side ever becomes worn.

Choose a plain outline for the handle (Fig. 10-5D), although a grip can be worked on it. A thicker part near the ferrule, tapering off to the end, is comfortable to hold.

Split turnings can be used to make handles that are thinner across when fixed to a tang, so the section is approximately elliptical and more like a hand-shaped slab handle (Fig. 10-6A). To do this the wood for turning has to be prepared in three pieces and glued together with paper in the joints (Fig. 10-6B). When the wood has been turned, a knife pressed into the paper joints will split them open. The central piece of wood may be discarded. The remaining paper is sanded off the slabs, and they can be fixed with pins in

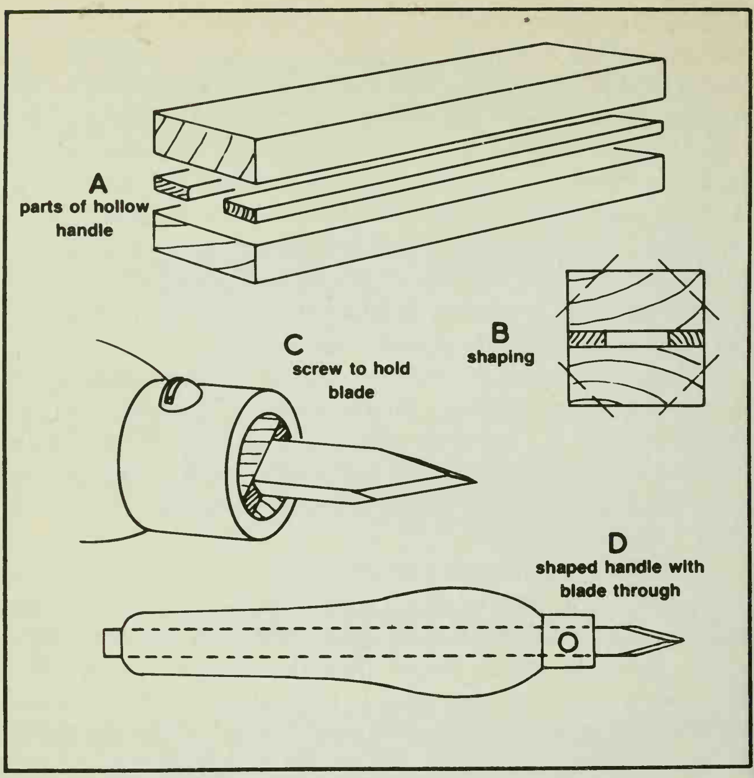


Fig. 10-5. Mount cutter's knife with hollow handle.

the usual way (Fig. 10-6). If the piece in the center is the same thickness as the tang, the finished handle would be round. It has to be made thicker to leave the slabs thinner, so the finished handle is elliptical. How much depends on what you want, but when you turn the handle, it is not the full diameter that has to match the tang. You set your calipers to the size at the paper glued joint (Fig. 10-6C).

If there is much shaping to a split turned handle, that outline has to be repeated on the tang, so the lengthwise shape should be kept simple. If the tang has a straight taper, the handle could match, but it may have shallow beads cut around it. There could be line decorations. After fixing, the tang may be brought to match with careful filing or grinding (Fig. 10-6D).

FINGER NOTCHES

For most purposes a plain handle is adequate, but for heavy

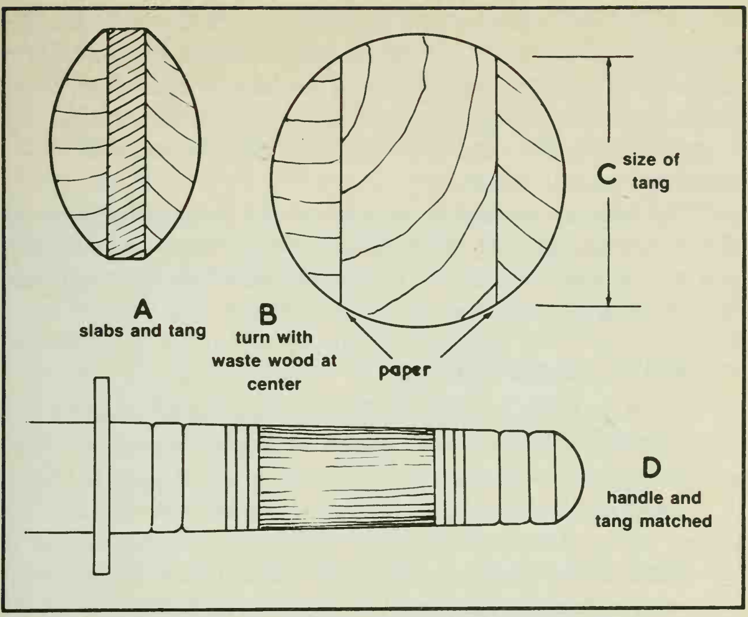


Fig. 10-6. Turned slabs are made on each side of a center that is removed.

cuts there is an advantage in providing finger notches so that the hand can exert maximum pressure without fear of slipping. There are some things to consider before making finger notches. It is usual to hollow them on one slab. Manufactured knives have them

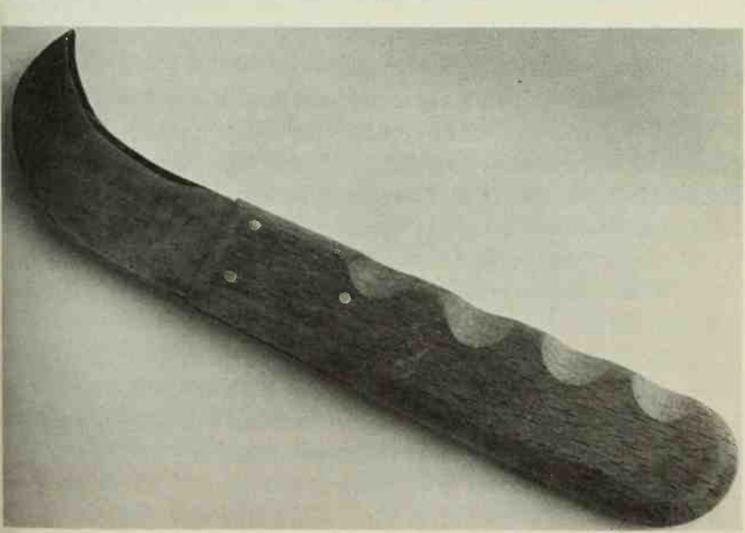


Fig. 10-7. A handle with finger notches in one side to suit a left-handed user.

arranged to suit right-handed users; you can make knife handles to suit left-handers (Fig. 10-7). An alternative is to take hollows right across one edge of the handle. They have to be filed or ground in the steel tang as well. This arrangement suits either hand, but is not as comfortable, and, if taken deeply and well rounded, it may weaken a narrow handle.

The notches are usually evenly divided along the handle, but if you experiment with the positions of your fingers on a handle, you can arrange notches at angles and spacings that suit your individual grip.

OTHER SLAB MATERIALS

Wood is the most easily worked of the handle materials, and for most knives it is the best choice. The great variety of colors and grain patterns offers scope for designs to suit all sorts of knives. It is comfortable to hold and reasonably immune to damage, but it may suffer if exposed to the weather, and water will affect it.

Other natural materials with handle possibilities are bone, ivory, and horn. If used for slabs, they can be sawn and sanded in a similar way to wood. Fine metalworking saws are less likely to cause splintering. The main problem is cutting so that flaws are avoided. Ivory or other tusk material is fairly uniform. Bones may have to be cut so much material is wasted, but it is often possible to arrange flaws on the inside where they are hidden against the tang. With some horn material, the outside surface can be retained to provide decoration and grip, but cuts have to be arranged carefully so matching pairs of slabs can be made.

The variety of plastics is considerable, and the characteristics vary. Only a few are really suitable for knife handles. There are phenolic resins in solid sheet and strip form, with patterns of various colors and some designs that imitate marble, tortoiseshell, and other natural materials. These can be sawn, filed, drilled, and sanded. They do not have a great resistance to impact, so they are not intended for rough use, but there are many knives with lighter uses that can be given very attractive plastic handles.

Another type of phenolic resin available is impregnated into paper, cloth, and other semiporous materials. These materials serve as reinforcement and decoration, so this resin will make a tougher and attractive handle. One trade name is Micarta.

Plastic can be sanded with wood and metal, but toward the finished state it is advisable to use clean sanding belts and buffs; otherwise, particles of metal may scratch or discolor the surface.

Buffing compounds are made for plastics, and it is advisable to use these on buffing wheels kept for their use only if the highest polish is to be obtained.

Most plastics are unsuitable for riveting. Pins can be used, but hammering rivets might cause cracking or chipping around the holes. An alternative to rivets is screwing. Phenolic resin can be threaded. Use brass machine screws with countersunk heads. Make clearance holes in the slab on the screw head side and in the tang and countersink to match the head. In the other slab, drill tapping size holes. They may be the same size as specified for metal or slightly larger to reduce any risk of cracking. Cut a full thread right through. Use glue between the slabs and the tang. Tighten the screws carefully, without excessive force at the end. Cut off any extending pieces of screws and polish the handle for the last time.

FLAT HANDLES

Although the majority of knives are used with a handle in line with the blade, there are some cuts better made with a handle above the cutting edge. The ulu (already described) is one, but veneers can be cut best with a knife having a handle extending along the top of the blade (Fig. 10-8A). The blade extends one or both ways so that it can be used either way. There could be rivets through the handle, but with the long slot to give a good area for adhesion, epoxy glue should be enough.

Fleshing knives and wood scrapers can also be made in this way (Fig. 10-8B). Both work crosswise and do not cut in the normal way. Both are tempered softer than a cutting knife—to purple or blue oxide colors.

A fleshing knife is sharpened like a cutting knife; then its edge is turned over by drawing a hard round steel rod burnisher along it (Fig. 10-8C). As the steel of the knife is not hard enough to be brittle, it curls without breaking. This edge is drawn across the inside of a skin to remove particles of flesh still remaining. The cutting edge is not always straight, and there can be several knives with different curves, but with the skin stretched flat, a straight edge with a slight rounding of the corners is common.

A wood scraper is sharpened differently. The steel is about $\frac{1}{16}$ inch thick. The edge is first filed square in section (Fig. 10-8D). It can be rubbed along an oilstone to remove the file marks. This is followed with a similar burnisher to that used on the fleshing knife, but it is tilted slightly each way as it is rubbed along so that the edges are turned over to slight curves—shown exaggerated (Fig.

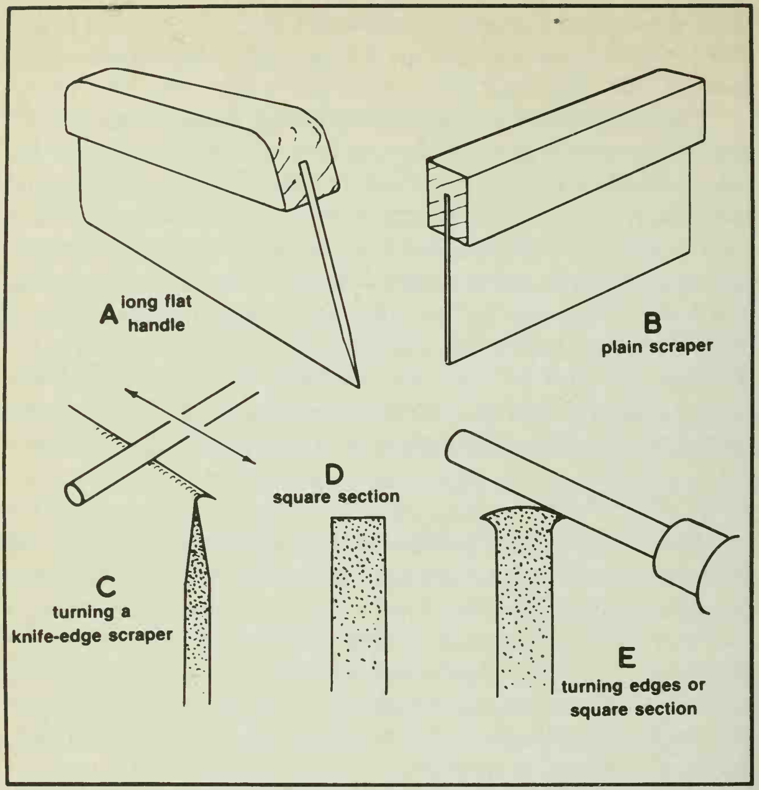

A long flat handle
B plain scraper
C turning a knife-edge scraper
D square section
E turning edges or square section

Fig. 10-8. Flat handles fit with grooves. Scrapers have their cutting edges turned over.

10-8E). When tilted and drawn across a wood surface these tiny cutting edges remove thin shavings and will smooth a surface that does not respond to a plane. An edge with a slight curve in the length can be used before a scraper with a straight edge. Resharpening is by further burnishing. Filing and the oilstone are used to restore a very worn edge.

The burnisher is a piece of round steel rod—$\frac{1}{4}$ inch will do—that is fully hardened. There is no need to temper it. Remember it is brittle and do not try to use it for other purposes. Having about 2 inches extending from a handle is satisfactory.

ONE-PIECE HORN HANDLES

Some horn and bone pieces suggest handles as they are. The pattern on an antler and its shape may be almost a ready-made handle with an attractive patterned grip. As some bones already have holes through them, they are a long way toward completion. Some of our early ancestors used these natural resources as handles for many tools besides knives.

If this type of handle is to be used, the tang has to be narrow, either square or round. With the usual method of knifemaking, the tang is the same thickness as the blade, so a thin piece of steel reduced in width to push into a hole would be weak. A bolster tight against the handle will help to strengthen it, but the weak point is where the small-sectioned tang enters the handle. A knife handled in this way should be made from fairly thick steel, even if much of it is ground away on the blade. It could be the type with a thick back, parallel in thickness for about half the width of the blade before tapering to the cutting edge. If it started as $\frac{3}{16}$ inch thick, the tang could taper from about $\frac{5}{16}$ to $\frac{3}{16}$ inch in width to have reasonable strength (Fig. 10-9A) if supplemented by a bolster. Factory-made knives have a forged round tang thicker than the blade, but this cannot be done with the usual individual knifemaking equipment.

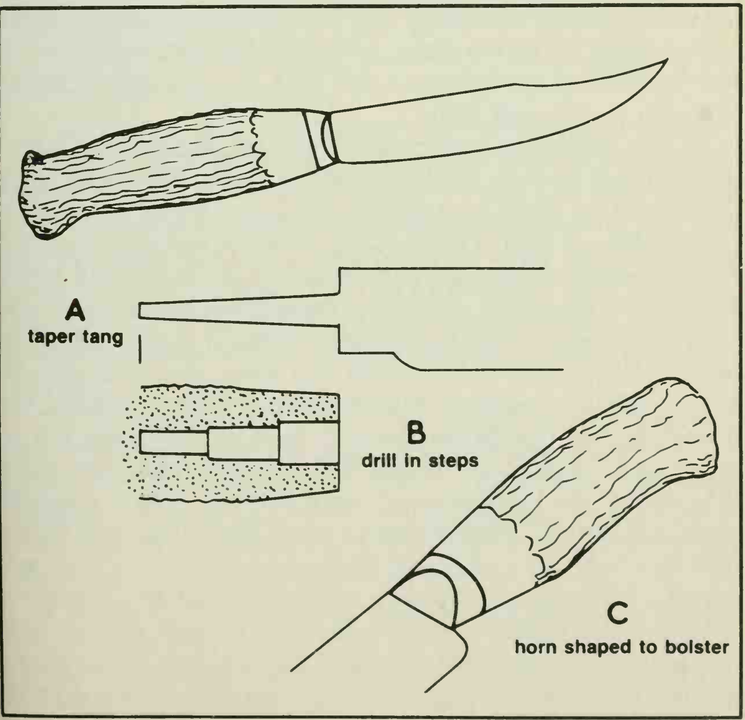


Fig. 10-9. Horn or bone may be drilled for a tang.

An advantage of a tapered tang is that it can be tried in the hole prepared for it. Level the end of the piece of horn or bone and support it in a vise for drilling, preferably in a drill press. Drill as far as the tang will go with a drill of about the size of the end of the tang. Enlarge the hole in steps with larger drills, until the tang will almost go in completely (Fig. 10-9B). The tang should not be a force fit, or the horn might split, but it should fit closely. Apply epoxy glue and squeeze the tang in.

If the horn or bone already has a hole that is larger than the tang, it can be packed to grip the steel. Glue alone will not provide the strength when used to fill a large space. If there is not much space to be filled, mix wood sawdust or chips from the horn or bone with epoxy glue. Put this in the hole and push the tang into it so that the surplus is squeezed out. Once the tang is in, do not move or disturb it. Support it unmoved until the glue has set.

If the space is much bigger than the tang, use a similar mixture, but supplement it with wood packings on each side of the tang. They can be wedge-shaped pieces thrust into the glue-dust mixture. Make sure that there is glue between the wood and the steel and that there are no air pockets. Use epoxy glue between the end of the handle and a bolster. If there is space, a few shallow holes can be drilled into the back of the bolster so that they fill with glue when the assembly is squeezed tight.

There could have been some preliminary shaping, but most of the work can be done after fixing to the blade. This allows some adjustment for slight errors in hole direction. File or grind down to the bolster and shape the end (Fig. 10-9C). It is common to leave the natural surface for most of the length of the handle, but where shaping has been done this can be brought smooth and polished.

Horn is affected by temperature. When it is very cold, it is brittle. Heat softens it. If working in a warm shop, that may be all the heating necessary to prevent splitting during assembly, but if you have any doubts, use moderate heat. Boiling water will do or use an oven at about the same temperature. Make sure there is no water in the hole during assembly. When sanding or polishing avoid overheating. Move the handle about. Prolonged work on one spot may raise the temperature there so much that the horn will partially disintegrate and leave a rough powdery surface. Even more heating would cause the surface to char. There is no cure then except to sand away the damaged surface and start again—assuming there is enough material left for you to do this. As with plastic handles, do not buff on the wheel used for metal, but you can use the same buffing wheels and compounds used on plastics.

One type of handle that is often seen on factory-produced knives should be avoided by individual knifemakers. This has a long stiff round tang right through the handle and a screw end to take a nut that lets into the butt plate. Between the bolster and the butt plate are pieces of material like washers, threaded on to make up the length. At the ends there may be pieces of brass on other metals alternating with pieces of fiber or plastic. The main part of the handle is wood or many washers of thick leather. The whole thing is then shaped and the different materials produce an attractive design on the handle.

To be successful and strong, the round tang has to be thicker than the blade. In industrial manufacture the whole steel assembly is forged. It may be possible to weld a rod to the blade, but it is difficult to get the assembly straight, and there is the further problem of cutting a thread on the end of the rod and making a fitted nut to let into a shaped butt plate. A skilled amateur might produce this sort of knife, but the average individual knifemaker will get more satisfaction out of making knives of the other types described in this book.

FINISHING

All metals, most plastics, and some bones and horns can be polished by working through a series of successively finer abrasives, down to grades that are so fine that we may call them polishes. The effect is to get a surface in which the marks from the abrasives are so minute that they cannot be seen, and we regard the finish as smooth and polished. The more thoroughly each finer grade removes the scratches from the previous one and the farther polishing is taken down the scale of fineness, the brighter the finish will be.

A few plastics benefit from the application of something to provide a base on which to polish, but many natural materials have pores to be filled before a good finish can be obtained. This applies to bones and horns to a limited extent, but wood is even more porous, and any polish that shows in the finished product is actually the shine on something applied to the wood.

Wood should be brought to as smooth a surface as possible with progressively finer abrasives (Fig. 10-10). At the end the wood may feel smooth and have a certain slight luster, but it is not a shine or polish. With the close-grained woods usually chosen for knife handles, the finish can be quite attractive, and some knife owners

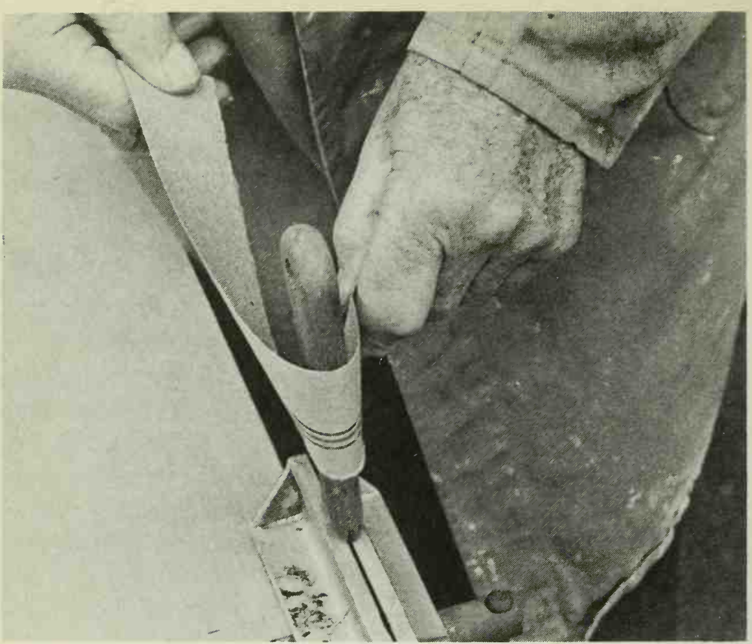


Fig. 10-10. A curved handle can be sanded by pulling a strip of abrasive paper around it, but final sanding should be along the grain.

prefer to leave the handle at that stage. Natural greases from the hand will impart a slight polish. If the knife is used with food, oils and greases from meat will add to the finish. For most knife handles, however, it is better to apply a finish.

Usually the wood is chosen for its color, and nothing is done to change it. Sometimes it is worthwhile emphasizing the color. A brown wood can be made browner and a red wood redder. It is usually unadvisable to change the color, and, for aesthetic reasons, to use a nonwood color. But if you want a green or blue wooden handle, that is possible.

Stains are water, oil, or spirit. Water stains are for large areas; they do not penetrate much. They are better avoided for knife handles. Oil stains are obtainable in a large range of wood shades. They can be brushed on or wiped on with a cloth. They dry in a few hours. One interesting treatment is to wipe away some of the stain after a short time to produce highlights. A handle may then finish with dark ends and a lighter center.

Spirit stains have alcohol as a solvent, so they dry quickly. On a large area this can be a nuisance as it may cause uneven staining because of drying, but a knife handle can be brushed all over before this happens, so the problem should not arise. Most of the range of bright colors, as well as wood shades, are available. As drying is almost instantaneous, further treatment can follow in a short time. Shading, as suggested for oil stains, cannot be done. Spirit stains are also suitable for leather, so they can be used on sheaths.

Final treatment can be little more than a thin gloss or luster close to the wood surface, or it can be a built-up layer that protects and carries the shine.

Nearest to the original natural finish from usage is rubbing with linseed oil. Oil is put on and left for a while. The surplus is then rubbed off with a piece of coarse fabric, such as burlap. The effect of the first application will not be much. There have to be many more applications at intervals, with occasional refreshers during the life of the knife. For an outdoorsman's knife this is a good traditional finish that may match a similar treatment of ax handles and canoe paddles. Linseed oil preserves and waterproofs.

There are prepared oils, sometimes called *teak oils*, that give a quicker but similar finish. Follow the directions supplied. Usually oil is put on and left for an hour or so then the surplus is polished off and the process is repeated once or twice more. Varnish in the oil helps to get a shine built up quicker than with oil only.

Another finish with similar appearance is wax. Our ancestors used beeswax, but this alone does not produce a very good sheen. Prepared wax polishes are mixtures of beeswax, carnauba wax, and other waxes that are rubbed on and polished off a few times to give a protective covering with an attractive luster.

Oil and wax penetrate the wood, and the thin film over the surface is so slight that the wood fibers appear polished. A thicker protective coat is provided by varnish. There are a great many varnishes. Shellac is not advised. This has an alcohol solvent, and the finish is neither very tough nor waterproof. Some other varnishes are intended for use indoors. As knife handles may be expected to get wet occasionally, even if not regularly used outdoors, it is better to use a varnish with a better water resistance.

There are still some varnishes made from natural materials, but it is better to choose a synthetic one. For the toughest finish there are two-part varnishes, which are mixed just before use. For general use on knife handles, a one-part good quality boat varnish is suitable. Varnish is best applied in dry, warm conditions. In wet weather or high humidity, or in temperatures approaching freezing, many varnishes will either not dry properly or they will *bloom* (dry with a cloudy appearance).

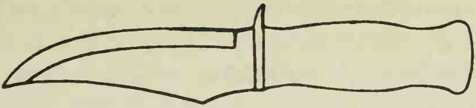
The best varnish finish is obtained with several thin coats, lightly rubbed by hand with fine abrasive between coats. Trying to put too much on in one coat will result in some of it running to a lower part.

It is possible to combine wax and varnish. One or two coats of varnish are put on and lightly rubbed with abrasive to remove most of the gloss. Wax is used over this, but as the varnish has sealed the wood and provided a base for polishing, results are much quicker than if wax were used alone.

Knife handles could be painted, but paint obscures the grain, and a more natural finish is usually desirable. It is possible to spray lacquer, but with the small area involved, much lacquer will go where it is not wanted. Spraying is used only for quantity production.

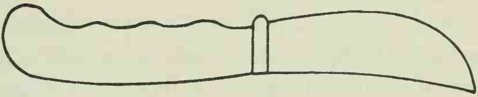
The majority of woods used for knife handles are close-grained and suitable for the treatments described without any preparation. If open-grained woods, such as oak or ash are used, it is advisable to fill the grain before polishing or varnishing; otherwise there will be hollows in the surface over the larger gaps. Wood filler is bought as a paste, which may be colored to match the wood. This is wiped around the handle so that some of it is caught in any gaps. After a short time the surplus is wiped off. Examination will show if a second application is needed. Some fillers are to be used before staining; other are better applied after stain. Read the instructions. After filling, any of the finishes just described can be used.

A few woods are naturally oily. The only one likely to be used for a knife handle is teak. The appropriate finish is teak oil. Teak is not usually varnished. Wood and horn should be made as smooth as possible. Then they can be wax polished.



Chapter 11

Sheaths



A sharp unprotected knife edge can be dangerous if left among other things that do not cut. Anyone sorting through these items may cut himself. As well as the risk to the person, there is a risk for the knife. A sharp edge is of necessity comparatively fragile, or it would not cut wood or other soft materials. It is not intended to cut metals, so if a knife is stored among many other metal things, its sharpness will soon be impaired. It is a waste of time to bring a knife edge to a high degree of sharpness and put it in a drawer with many other knives and other metal tools. If an edge is to remain sharp, it should be covered during storage. If there is a risk that the edge might be touched while the knife is out of use, it should be covered. A secondary consideration is the problem of rust.

Plain carbon tool steel will corrode in the presence of moisture. Regular use limits the risk of this happening, but when a knife is left unused for some time, the surface is liable to become rusty. Minor rusting is easily cleaned off and may not do any harm, but prolonged rusting pits the surface of the metal and has to be ground away. Sharpening where there has been deep rusting will produce a broken blunt edge where the pitting has been. Prevention is much better than a partial cure.

Wrapping or making sheaths with plastic or other impermeable material may seem a good way to keep moisture out, but it also keeps in moisture that has been trapped. This includes moisture in the air. If the air trapped with a knife blade is absolutely dry, there will be no rust, but if there is any moisture, rusting may be worse than without the covering. Covering the blade with oil or a rust inhibiting fluid before wrapping will stop rusting. There could be a sachet of silica gel included in the wrapping. This draws moisture to itself and has to be dried if it becomes saturated. It is more suitable for use with many knives in one storage place than with a single wrapped knife. Oiling, or inhibiting, then wrapping in ordinary cloth (which is porous) is probably better than using close plastic covering.

If a sharp knife, such as a carving knife, is to be kept with other knives and kitchen tools, it may be given a sheath made from card. It is best to wrap the card so that there is a double thickness over the cutting edge (Fig. 11-1A). The card can be glued or wrapped with masking tape. If there is a guard, the sheath goes over the blade only, but if there is nothing projecting, it is better to go a short distance over the handle (Fig. 11-1B).

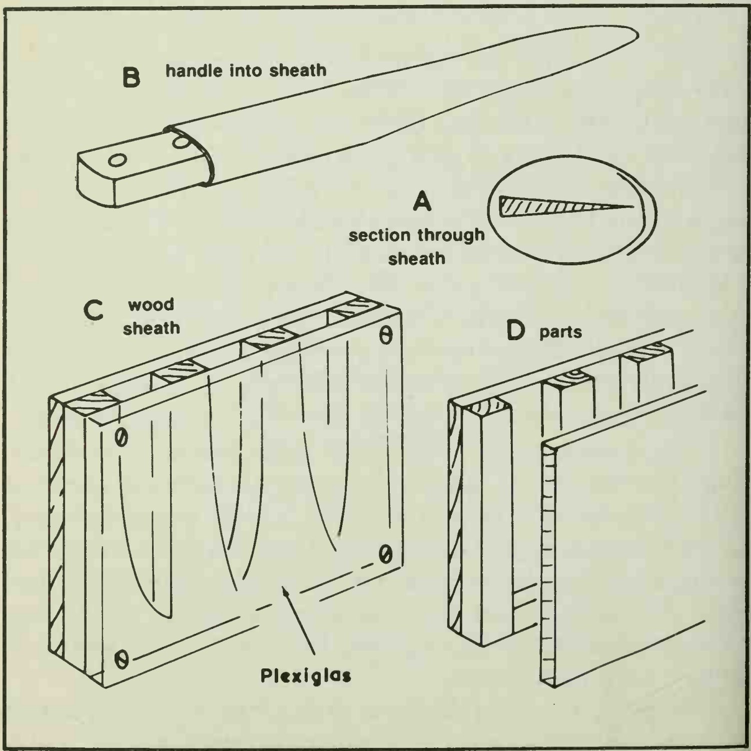


Fig. 11-1. Kitchen knives may be fitted with card sheaths or stored in a standard rack.

It is better to mount a group of kitchen knives in a wooden rack. The wood can be cut out to the shapes of the blades (Fig. 11-1C), although it may be simpler to build up with strips of wood. Then it does not matter which way round the knives are inserted (Fig. 11-1D). The front could be a piece of plywood, but if Plexiglas or other transparent plastic is used, the blades can be seen, which helps in selecting the right one for a purpose. A similar idea can be used for some individual knives—a bread knife may fit in a slot in the side of a bread board.

Knives, chisels, and other cutting tools used on a bench should be stored so that the edges are protected and prevented from doing damage. Too often they are left amid a jumble of other tools or put with them in a box or drawer. A rack similar to that described for kitchen knives can be fixed to the wall above a bench or inside a tool cupboard.

LEATHER

A knife that has to be taken with you is most conveniently put in a sheath on your belt. This applies to many knives used by carpenters, sailors, and others, as well as the more obvious hunting knives. Some sheaths have been made of wood and other materials, but the best choice is leather. It is important that the sheath provides full protection at all times and is not likely to deteriorate or fail in use. A knife point breaking through the end of a sheath unexpectedly can be very hazardous. Similarly, a sheath that is soft and limp may turn over and allow the knife to fall out.

Leather chosen for a sheath should usually be hide of sufficient thickness and tanned so that it is stiff (see Chapter 3). Soft leathers used for bags and decorative leatherwork should be avoided. The usual sheath leather has a smooth unmarked outer surface and a reasonably smooth matt inner surface. To retain adequate stiffness during its life, the thickness will probably be near $\frac{1}{8}$ inch for an average knife. It could be much thinner for something like a fruit knife or thicker for a large hunting knife.

For safety reasons the sheath should be designed so that most of the knife is below belt level, keeping its weight and center of gravity low. That minimizes the risk of the knife's turning the sheath over and falling out or being dislodged by a knock (Fig. 11-2). If there is no projecting guard, it is wise to let about half the handle follow the blade into the sheath (Figs. 11-4 and 11-5A). If there is a guard, the part over the blade stops there and something has to be done to hold the handle, or there is a risk of the knife turning

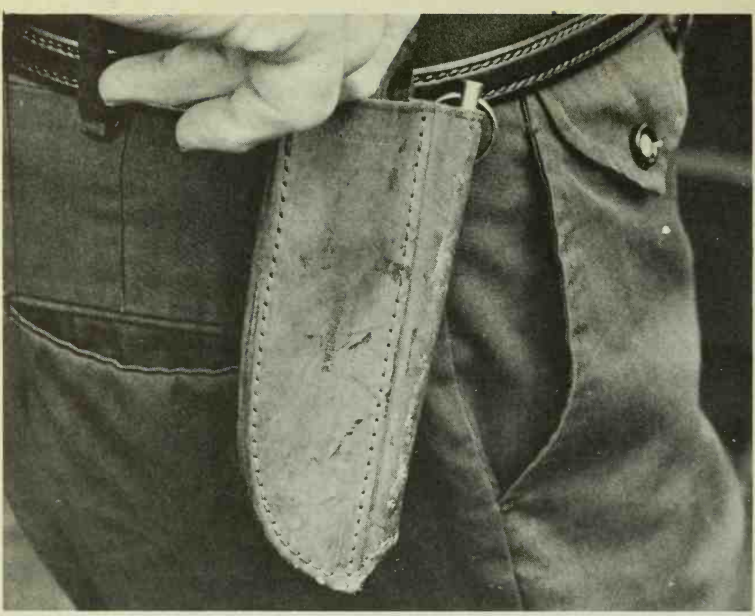


Fig. 11-2. A sheath should hold a knife so that most of its weight is below the belt and there is no risk of it turning over.

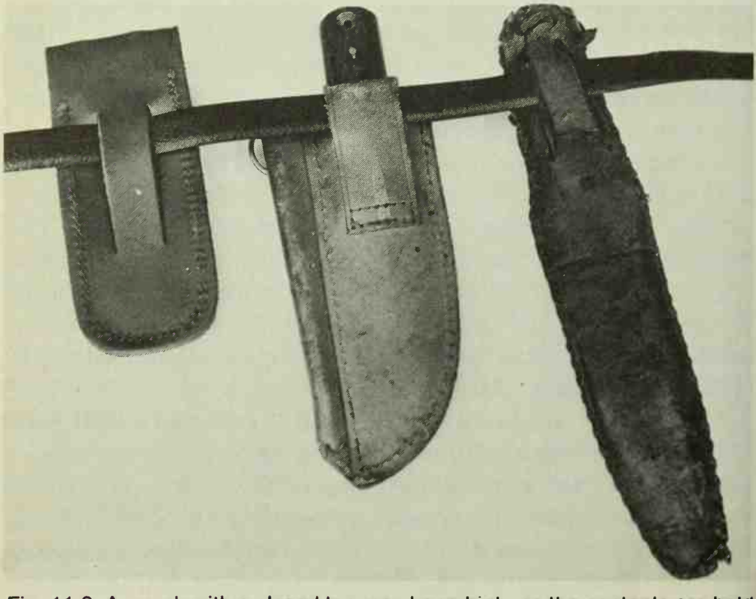


Fig. 11-3. A pouch with a closed top may hang high, as the contents are held with a flap, but an open sheath should have a loop or slots so that the knife is low.

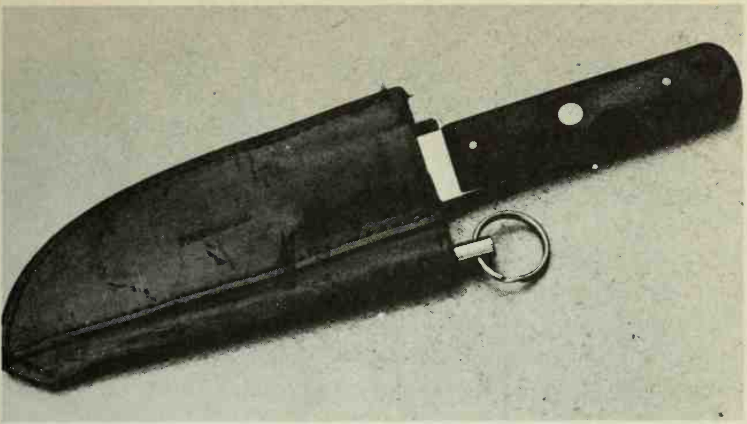


Fig. 11-4. The knife enters this sheath as far as the center rivet in the handle, ensuring its total weight is low.

over. This is usually a strap with some sort of fastener (Fig. 11-5B) arranged high enough on the back flap to keep the handle upright, but not so high that there is a risk of its lifting over the top.

A third sheath for a knife with a finger guard is suitable for one with a blade longer than the handle. A knife with a long heavy handle might tip this sheath, although the strap should prevent it from coming out. The sheath is shaped to the guard, and a strap goes diagonally over the finger guard to a snap on the front (Fig. 11-5C).

A sheath that encloses part of the handle is hung from the belt with a loop sewn on (Figs. 11-5D and 11-6). A sheath with a strap around the handle could have a loop sewn on, but another way is to fold the sheath leather itself over to make the belt loop (Fig. 11-5E). Some of these sheaths have the back slotted for the belt to pass through (Fig. 11-5F). The round holes punched at the ends of the slots prevent the cuts from splitting farther. If the leather itself is not stiff enough, a piece can be glued and sewn at the back to reinforce the slotted part. The third type of sheath is best given a loop sewn on as high as it can be conveniently arranged behind the part enclosing the handle.

There can be multiple sheaths. A hanging sheath from a belt may include other tools besides a knife. A sailor may want a marline spike alongside the knife, and there might be a loop to carry a pair of pliers in front of the knife. Obviously, there are limits, as too complex a sheath would be cumbersome. It might be better to have two sheaths arranged at opposite sides of the belt. Another multiple

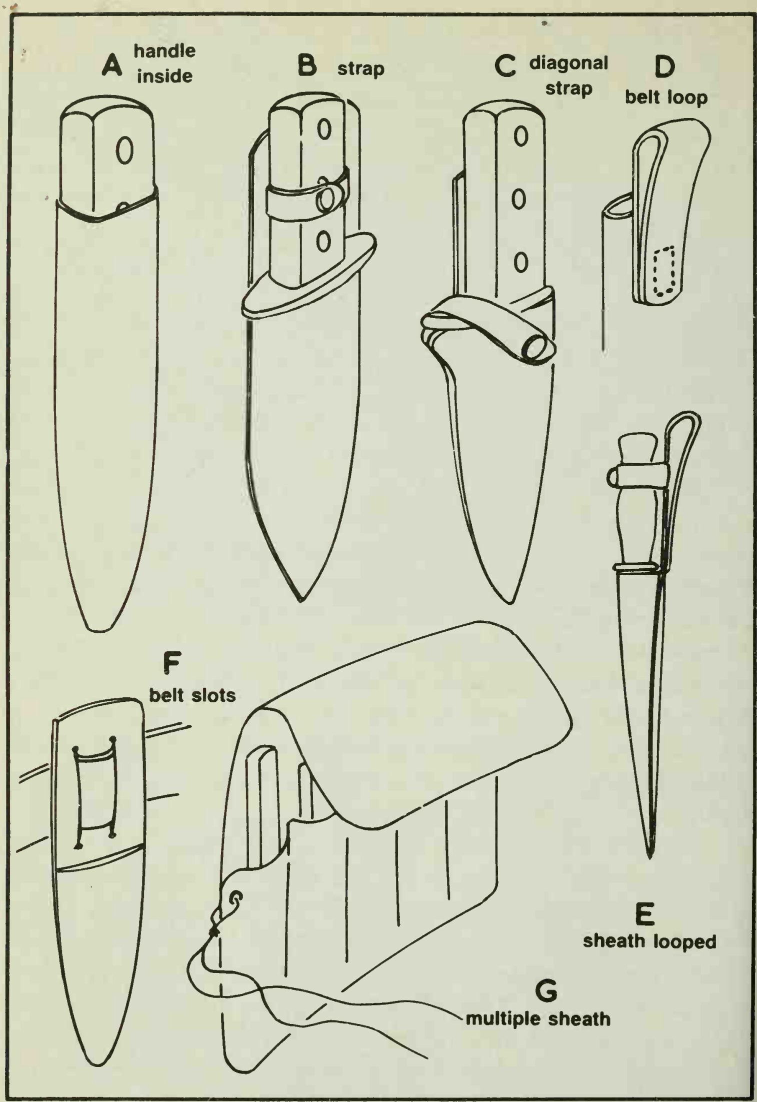


Fig. 11-5. A leather sheath may enclose part of the handle or hold it with a strap. There can be a loop or slots for a belt. Several knives can be kept in compartments in a roll.

sheath could be used for several kitchen knives. It could be more flexible leather with the slots quite loosely arranged on the blades so that the whole thing could be rolled. A flap at the top folds over the handles; a thong could be arranged to tie around the roll (Fig. 11-5G).

SEWING

Sheaths may be sewn, thonged, or riveted. Sewing is most common, but rivets may be used with it as reinforcement. Thonging is done for decoration. The thread used for sewing should be the stout type intended for leatherwork. Before use it should be drawn through wax, which could be the wax used for wood polishing or a block of harder wax. While sewing, this keeps the stitches tight, and it prevents the thread from rotting. Some cobblers stiffen the end of a piece of thread and use it without a needle, but that is an acquired skill and it is easier to use needles, which can be any plain type with a hole large enough to take thread. Special leatherworking needles are shorter and have more obtuse points than general sewing needles, but there is no need to buy them if others are available.

Mechanical sewing of leather has to be done with a special heavy-duty machine. If one is available, it can be used, but it is more likely that a sheath will have to be sewn by hand. As the amount is not great, this is not a very tedious process, and there is considerable satisfaction to be gained by neatly sewing the sheath seams.

Holes have to be made, and it is common to let the stitches into the surface of the leather. A stitch punch is a useful tool as it makes four or more holes at the same time (Figs. 11-7A and 4-20E). Their spacing must be even, but this punch will not follow around a very close curve nor deal with short distances. A single

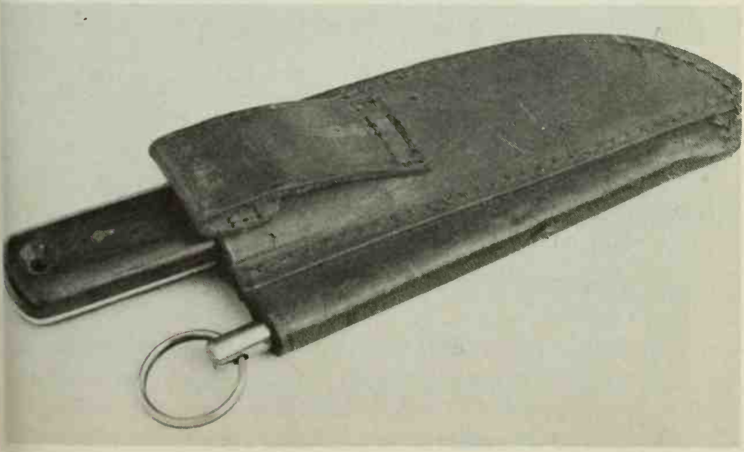


Fig. 11-6. A loop is the best way of hanging a pouch sheath from a belt.

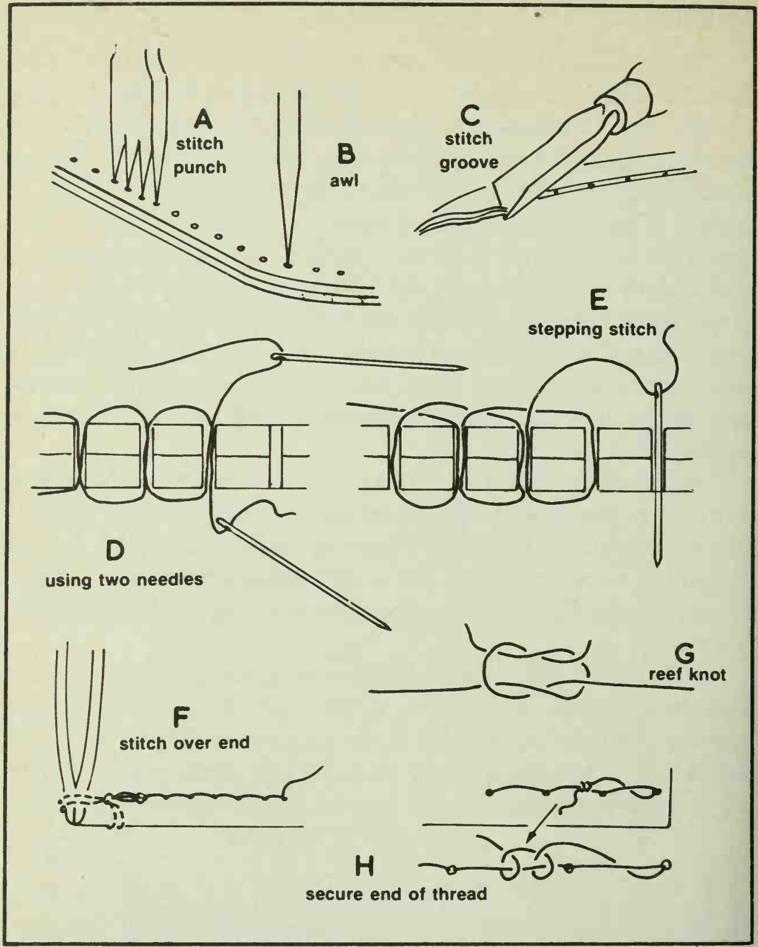


Fig. 11-7. Holes for stitching should be punched. Two ways of stitching are shown. The start has multiple stitches. Ends should be knotted.

punch has to be used for those places. This can be a handled awl, pushed through by hand, or a pointed piece of steel hit with a hammer (Fig. 11-7B). The spacing of holes will depend on the thickness of leather and thread, but five or six to an inch should be satisfactory.

After making the holes, groove the surface over them to let the stitches in. The groove should be only enough to bring the stitches level—going too deeply would weaken the leather. A woodcarver's V-tool could be used, but there are sets of tools, little bigger than old-style pen nibs, that fit into a holder, and one of these gougelike tools with a V-section is a very suitable tool (Fig. 11-7C). With the punched holes as a guide, go around removing a small sliver of leather. Keep the point of the tool very sharp.

There are several ways of sewing leather, but two are most suitable for sheaths. One involves two needles on the same length of thread, working from opposite sides in turn (Figs. 11-7 and 11-8). The other suitable method uses one needle in a stepping stitch. On the front the needle goes two holes forward each time, while underneath it goes back one hole (Fig. 11-7E). The effect is to produce single thread stitches on the back, but an overlapping double thread pattern on the front. In both methods, every stitch should be pulled tightly as it is made. It is no use trying to tension after several stitches. If necessary, use pliers on the thread.

The greatest load on stitching is at the entrance to the sheath. Some sheaths have a rivet there, but even then the stitching should be strengthened. There can be two larger holes, and the thread can be taken through them several times before starting along the seam (Fig. 11-7F). Thread can go around the edges in both directions as well. At the end of a seam, tie off the thread. If you are working with two ends, use a *reef knot* (Fig. 11-7G) in the groove at the back. Trim off any surplus. If using a single thread, take the needle back

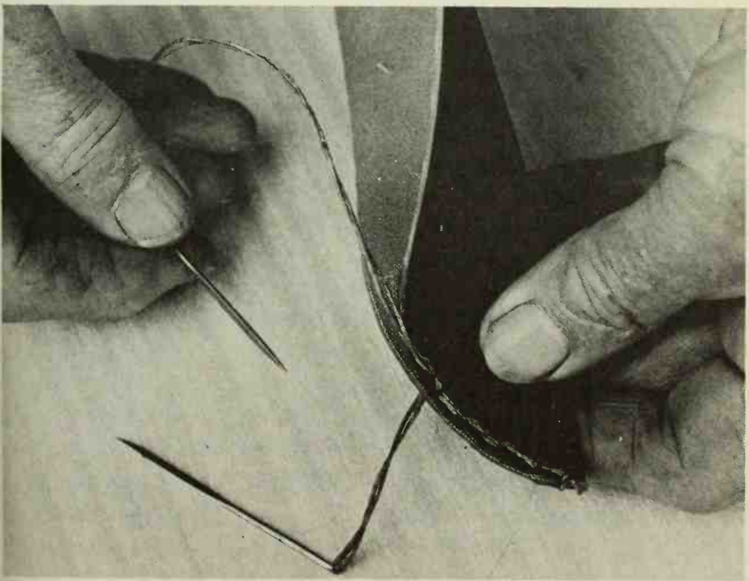


Fig. 11-8. The edges of a sheath begin sewn together with waxed thread and two needles.

through a stitch on the underside and half hitch the thread twice around another stitch (Fig. 11-7H), before cutting off.

THONGING

The edges of leather may be sewn with leather thongs. These can be bought in long lengths. There are similar plastic thongs available in leather colors and some bright colors, which might be attractive on a decorative sheath. It is also possible to make thongs from small pieces of leather, by cutting spirally—a surprisingly long piece can be made from a small circle of leather. Use a knife with a sharp point and rotate the leather against it (Fig. 11-9A) to make a thong about $\frac{1}{8}$-inch wide. After cutting, soak the leather in water to make it limp then pull it straight. Hang with a weight to dry.

To make a temporary hard point on the thong, use aluminum or tinplate cut from a discarded can into $\frac{1}{2}$-inch wide strips with snips or old scissors. Fold the end of a strip over a thong and

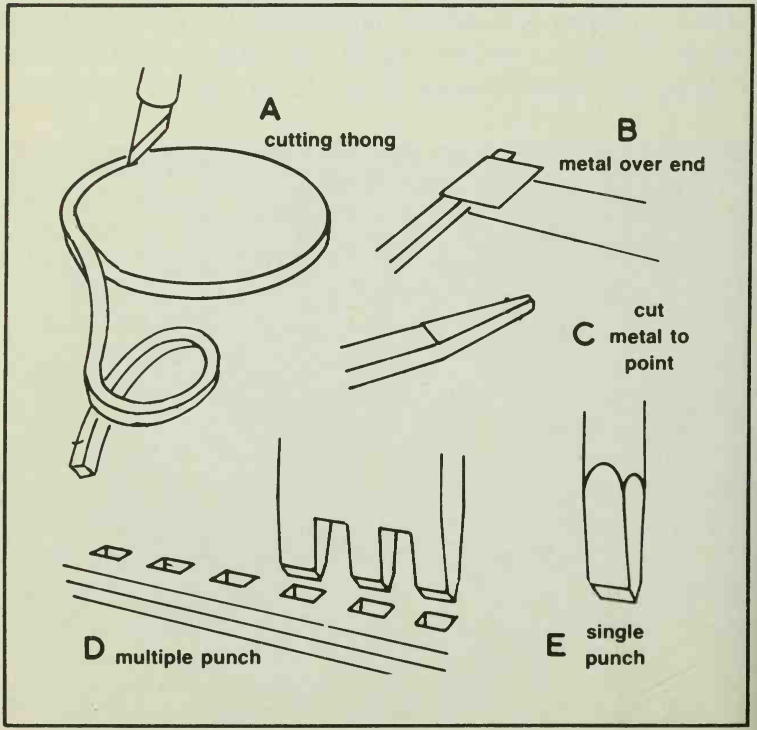


Fig. 11-9. A leather thong can be cut spirally. A metal point helps threading. Holes are punched to suit the thong.

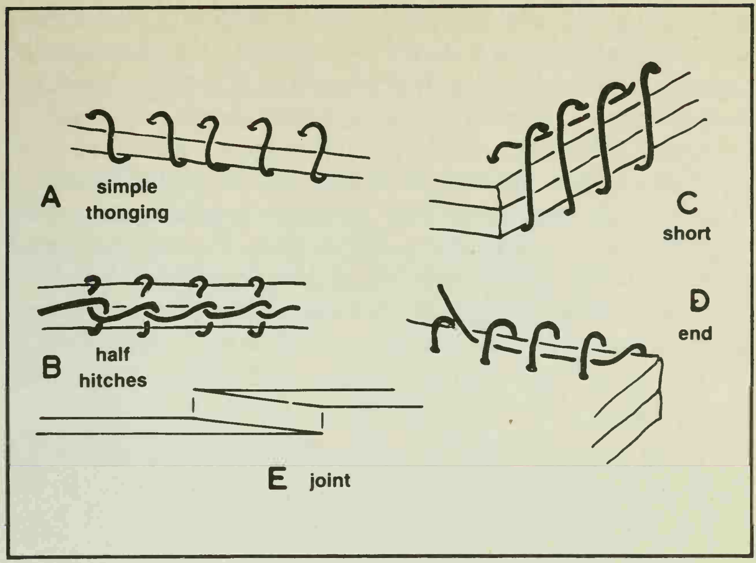


Fig. 11-10. Thonging may be plain or half hitched. Ends are locked under stitches.

hammer it flat (Fig. 11-9B) then cut thong and metal almost to a point (Fig. 11-9C).

Thonging is often done through holes made with a single or plier-action punch that makes round holes (Figs. 4-20G and 4-20H). Part of the hole shows after thonging, which may be acceptable, but it is neater to use a hammer and punch that makes holes of the same shape as the thong (Fig. 11-9D). It could be a single punch or one with several cutters (Fig. 11-9E and 4-20F). The space between two thong holes should be only just enough to pass a thong. There will be none of the obvious gaps behind the thonging that there are when round holes are punched.

The simplest method of thonging is a simple over and over (Fig. 11-10A). This gives a compact and neat finish. Another way half hitches each stitch into the previous one and gives a sort of spiral roll effect along the edge (Fig. 11-10B). It is useful to have an awl or spike with a rounded tip to hook under each stitch as it is made to pull tight, which is a better way of tensioning than pulling directly on the thong.

At the start of thonging, lay the end along the back of the sheath far enough to be covered by about three stitches (Fig. 11-10C). Finish a seam in a similar way, but make the last three stitches loosely and tuck the end under them (Fig. 11-10D). Draw the stitches tight in turn with a spike, pull the end tight, and cut it off. An average sheath can probably be laced with a single thong, but if thongs have to be joined, it is possible to take the turns of one part over the end of the other, so it is held tightly at the back of the sheath before being worked along the edge. It is also possible to splice one piece to another. This is done by paring both ends to match with long bevels (Fig. 11-10E) and joining them with leather cement (cobbler's adhesive or glue). Put the joint under pressure until the glue has set. When thonging is continued, press the spliced part carefully into place in its holes. The joint should be almost invisible.

RIVETING

Metal bifurcated (two-pointed) rivets can be obtained in many lengths and with various finishes. The length of the solid part should be less than the thickness it is to go through (Fig. 11-11A). If the

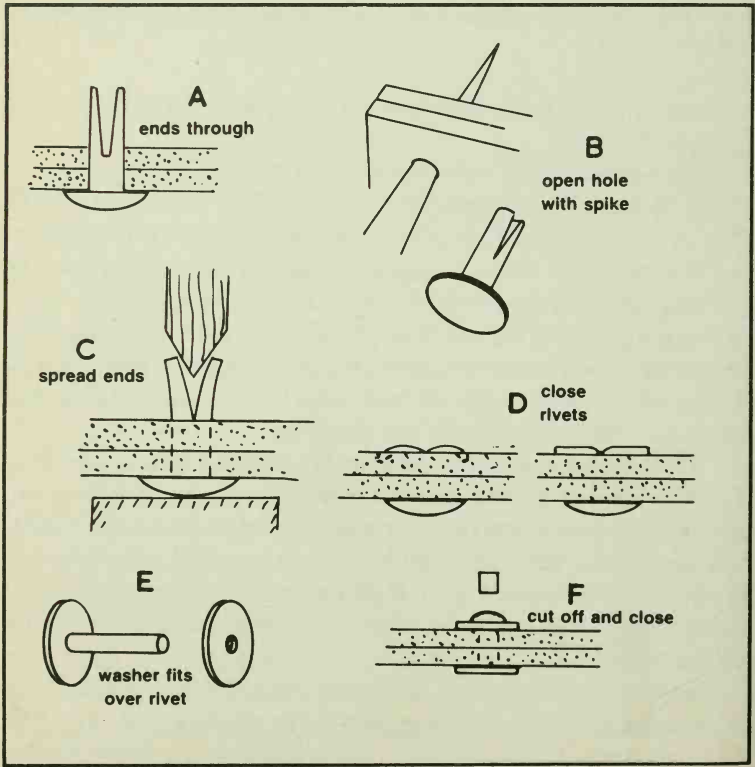


Fig. 11-11. Bifurcated and plain rivets supplement stitching.

ends are too long, they can be cut off. For sheaths, a coppered or plated finish may be used.

The hole punched for a rivet should be a very close fit for greatest strength. It could be slightly undersize. Then a tapered spike is pushed through and the rivet inserted before the leather shrinks back (Fig. 11-11B). The head needs firm support, but using an iron block might damage the plating. A block of hardwood is better. Spread the points slightly, either with a screwdriver or a wedge-shaped scrap of wood (Fig. 11-11C). Lightly hammer directly on top so that the points will curl. Further hitting will bury them in the leather. If the first blows are heavy, they will merely flatten and the points will remain on the surface (Fig. 11-11D).

Another type of rivet is made of copper, with a broad flat head and a washer of the same size (Fig. 11-11E). The rivet goes through the leather from the front; the washer is driven over its end, preferably with a hollow punch. The end is cut off a short distance above the washer, and the remaining piece is spread with light hammer blows (Fig. 11-11F). Bifurcated rivets are steel and may rust through the plating, but copper rivets will be unaffected by dampness.

There are other rivets used in leatherwork, but most of them need a spinning action to close them in a machine, so they are more suitable for factory production.

SNAPS

Fasteners for the straps around the handles of some sheaths come in several patterns, but a useful one is in four parts—two for each part of the strap. There are special setting tools intended to be hit with a hammer or squeezed in a plier-type holder. With some types of plier punches, there are snap setting heads that can be fitted in place of the punches. However, it is possible to set the four-part snap (press stud) with ordinary tools.

The lower pair of parts have a bottom piece with a tube that goes through the leather and into the upper part, where it can be spread with an ordinary center punch (Fig. 11-12A). Make the hole in the leather a tight fit on the tubular part. The usual size snap suits leather of average thickness, but check that the end of the tube does not stand above the top of the other part before closing. If it does, file some of the end away.

The upper part includes a dished piece with a spring ring that engages with the lower part, and is fixed to a domed top. As the domed top is the part that shows in the finished sheath, be careful

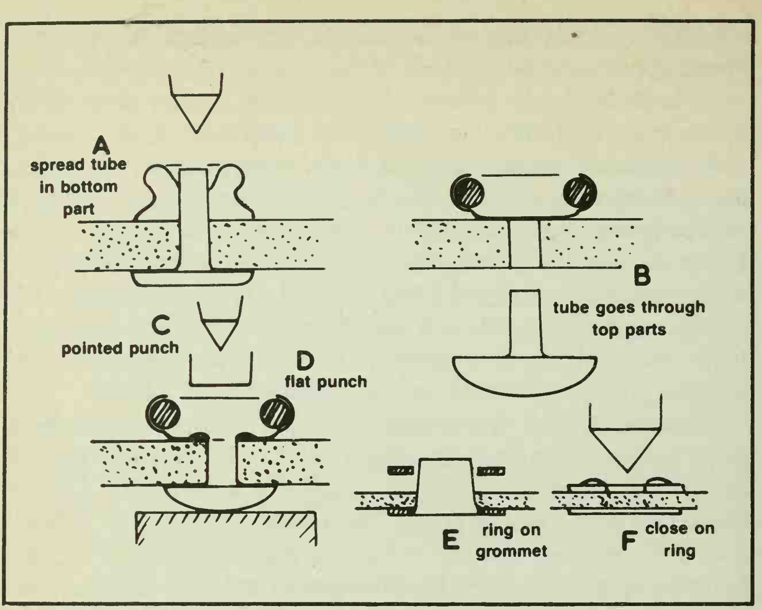


Fig. 11-12. Snap parts can be fitted with punches.

not to damage it. It could be supported on a piece of wood, but a lead block gives firmer support and soon develops a hollow to match the dome. A tubular piece from this goes through a hole in the leather and projects into the spring piece (Fig. 11-12B). As with the other pair of parts, check that there is not too much tube projecting. Spread it first with a center punch (Fig. 11-12C) then with a flat-ended punch (nail punch) (Fig. 11-12D). If there is too much tube projecting, the end will split under the punches, and some of the metal may stand up around the spring ring and interfere with its grip of the lower part.

In some sheaths the attached laces or tying thongs should go through holes lined with *grommets* (eyelets). These are usually brass, but their faces may be enameled, plated, or coated with plastic. The smallest and simplest grommets are single pieces. Larger and better ones are in two parts. Both are fitted in the same way. The best tools are punches and dies made to match the particular grommets and are either hammered or in plier form. Alternatives are the punches suggested for closing snaps. Put the eyelet through a slightly undersize hole that is forced open with a tapered spike just before fitting. Have the prepared face on the outside. If there is a ring, put it over the projecting tube (Fig. 11-12E). Support it on an iron block or a piece of lead. Spread the tube with a center punch (Fig. 11-12F) and follow with a flat-ended punch or direct hammering. Get the grommet tight on the leather, but do not continue hammering so hard that both sides of the grommet are knocked out of shape.

POUCH SHEATH

A sheath for a knife with a handle that continues the line of the blade without a projecting guard should be laid out so that the leather has its top about halfway up the handle and so that when the knife is rolled over, there is a border wide enough to keep the stitching clear of the edge (Fig. 11-13A). It may be advisable to experiment with flexible card before cutting the leather, but if this is used as a template, cut outside the line a little to allow for the different bending of the thicker leather (Fig. 11-14).

If the blade point sweeps up to a straight back, the sheath shape goes to a point on the fold (Fig. 11-13B), but otherwise allow for stitching both sides of the point (Fig. 11-13C). Some of these sheaths are made with the two sides glued and stitched directly, which may be satisfactory, but there is a risk that the thin sharp edge may cut into the glue line and damage the stitches. It is better to include a narrow strip of thin leather in the joint (Fig. 11-13D).

With the usual leather left as it is, the thickness at the joint

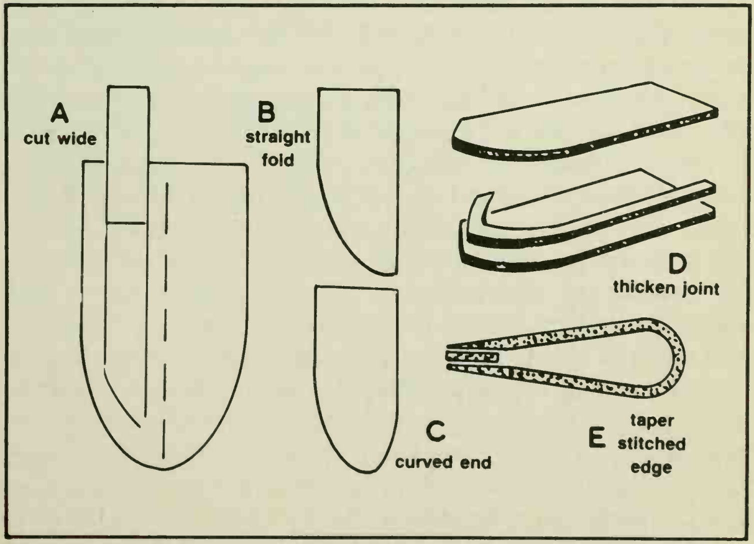


Fig. 11-13. Get the sheath shape from the knife. Make a thin filler piece against the blade and taper the outside over this.

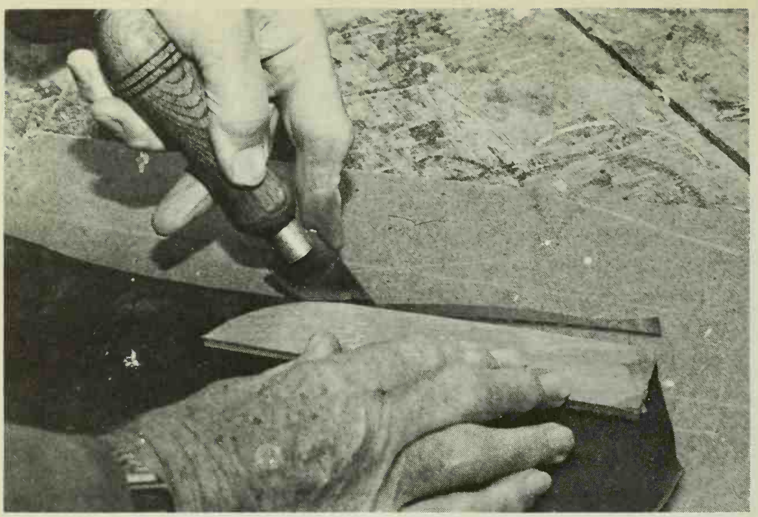


Fig. 11-14. Using a template while cutting leather for a sheath.

would be unnecessarily thick and difficult to sew. The folded edges should be tapered on their meeting surfaces, and the filler piece should be reduced to about the blade thickness or less (Fig. 11-13E). A regular leatherworker would do this by paring with a knife or a chisel-like edge beveler, but if a belt sander is available, the work can be done on that. Apply pressure with a piece of wood. If a thin piece of leather cannot be found for the filler, normal leather can be pared down with a knife. The inner edge of the filler should follow the curve of the blade, with a little clearance. Its outer edge will match the case, but some can be left for trimming after gluing.

Before joining the blade case, make the belt strap. This is a piece of leather folded and sewn. The ends may be thinned slightly where they meet to reduce bulk, but do not take off too much or the strap will be weakened (Fig. 11-15A). Another way is to sew the strap at two places (Fig. 11-15B). The leather may be limp enough to bend dry, but it is better to soak it in water for 10 minutes and fold it to shape. Press it lightly under weights while it dries so that it retains the shape. The cut edge may be satisfactory as it is, but it can be improved by following around with a hollow-ended edge beveler to lightly round it on both surfaces (Fig. 11-13C). Glue the meeting surfaces together. Punch holes for sewing—a pattern of six or eight should be enough (Fig. 11-15D)—and sew the strap to the back of the sheath. The top of the loop should be a little way above the edge of the sheath (Fig. 11-15E). Groove the inside of the sheath along the lines of stitching so that there is no risk of the stitches coming into contact with the knife and being damaged.

Fold over the seam and glue the filler piece in with leather cement. Cut edges show lighter than the surface of the leather, so you may wish to dye them. Some makers do this before gluing the leather. There is a problem whichever way you do it. Dye on meeting surfaces will interfere with the penetration of the glue. Glue on the dyed surface will cause uneven coloring. This means that care is needed not to get glue or dye where it is not wanted. Leather dye is similar to spirit stain for wood and can be applied with a fine brush. Some dye is supplied with a little pad on a wire handle, which gives less risk of excess dye being deposited. As glued and sewn surfaces often need leveling after sewing, it is probably better to leave staining until the last stage, but be careful to avoid glue running over the edges when it is applied. The color of the sheath can be altered by staining all over, inside and out, but keep stain away from the surfaces that will be glued.

For a simple sheath and the usual leather, it will probably be possible to fold the parts dry, but otherwise soak the leather for 10 minutes in water and fold it over the knife to get the shape. To avoid the risk of rusting the blade, wrap it closely with scotch tape, plastic sheet, or masking tape. Bending wet is advisable if the handle is thick. It is then possible to mold the leather with your

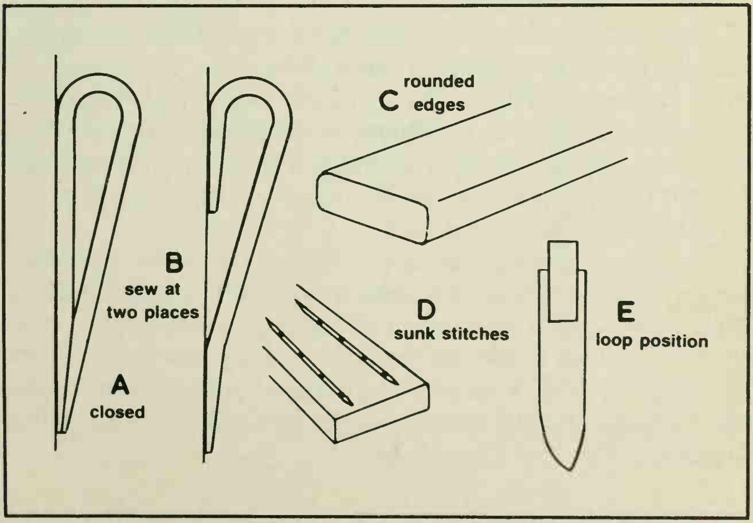


Fig. 11-15. A belt loop has its stitches sunk below the surface and is arranged high enough to prevent the knife from tilting.

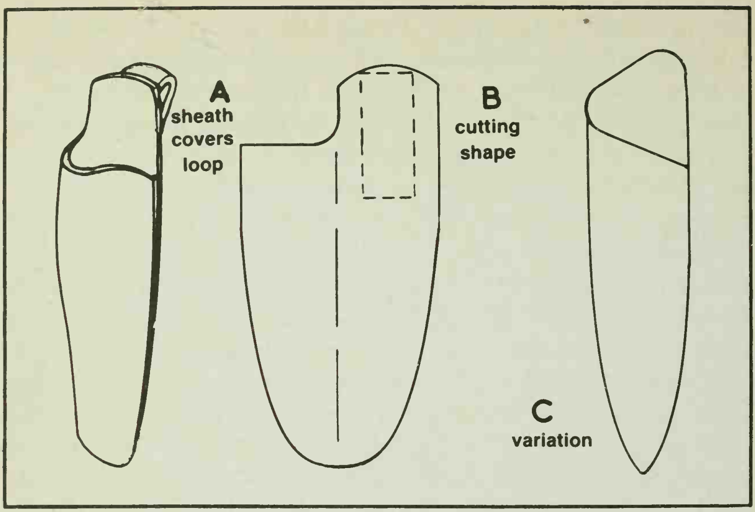


Fig. 11-16. A looped sheath may have the back extended or cut sloping.

hands so that the top of the sheath confirms to the shape of the part of the handle that is enclosed, while leaving the lower part to match the blade.

Sew around the seam. Make two larger holes for multiple stitching at the top and other holes for normal stitching. Groove the surfaces to sink the thread. Use the thread tightly in one of the ways shown in Fig. 11-7.

There may have to be some experimenting to get sizes right. And the thickness of the filler piece affects this. There has to be more clearance inside with a thin piece than with a thick one. Enough handle has to be enclosed to ensure security, but there must be enough exposed to allow gripping. The amount the belt loop extends is affected by the size of the knife. A long knife need not be slung as low as a short one.

There are not many variations possible, or advisable, in a pouch sheath. There can be an extension of the sheath over the belt loop (Fig. 11-16A). This is cut when laying out the shape and may be sewn to the loop to give the sheath a steadier attachment to the belt (Fig. 11-16B). A variation on this uses a diagonal cut at the top, so there is a protective piece at the back and a more accessible opening at the front (Fig. 11-16C).

SNAP POUCH SHEATH

A variation on the diagonally cut pouch sheath can be used for a small knife with a guard. A snap is used on a strap to go over the guard and retain the knife (Fig. 11-17A). Experiment with a paper or card shape and use it as a template when a satisfactory outline is obtained. The way the strap is arranged depends on the pattern of the guard. Extensions of the front and back parts can go completely or partly over the guard. Then the angle of the strap allows it to swing over, and the two parts of the snap meet over the center of the front (Fig. 11-17B).

Bend the leather to shape, dry or wet, and make it up with a filler glued in, in a similar way to the simple pouch sheath, but before doing this, position the lower part of the snap. So the metal inside will not touch the blade, cover it with a piece of thin leather, with its edges tapered to a feather edge (Fig. 11-17C) and glued in place. Allow a little extra on the length of the strap that comes over this so that the upper part of the snap can be positioned and the strap cut as the last part of the assembly. Round the edges of the strap, but do not cut it too close to the snap. A small amount at the end provides a grip for lifting.

This type of sheath looks best if the top is cut diagonally so

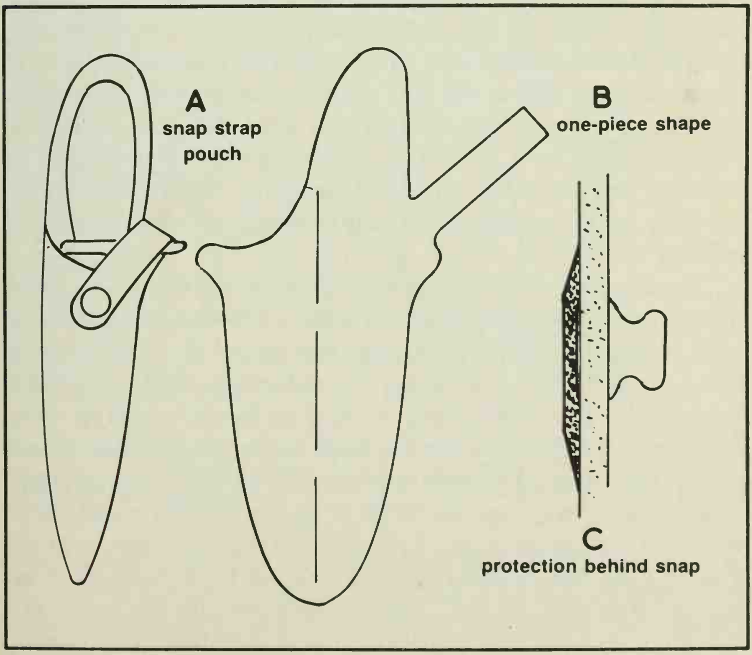


Fig. 11-17. One way of retaining a knife with a guard is to use a strap from one side.

that the back sweeps down to the strapped front. It could be made straight across, or it could be extended upward in a similar way to the next sheath.

STRAPPED SHEATH

Any type of knife could have a sheath where only the blade is enclosed. Then the handle is secured with a strap, but it is particularly suitable for a knife with a large bolster or guard (Figs. 11-18A and 11-19). The sheath should be designed so that all, or nearly all, of the knife comes below the belt. If there is a blade much wider than the handle, the whole sheath is usually made to the greatest width needed, but the strap around the handle may be offset to allow for the narrower handle. However, if the blade is almost symmetrical and could go into the case either way, it is better to arrange the strap centrally. There are several ways of slinging this type of sheath, and the first described uses an extension of the sheath back to make a loop.

Although it would be possible to make a sheath with the case in one part folded over a knife with a straight back, in a similar way to a pouch sheath, knives with large guards usually have shaped backs to the blades. It is better to make the front of the sheath separate from the back and sew all around. This means that there is a front piece of leather cut with enough clearance all around the top edge to come against the guard, a filler that goes all around the blade and a back, with its face side forward, that extends to make the belt loop (Fig. 11-18B). The extension can be reduced in width, but it is probably better to keep it full width to reduce swaying on the belt.

For this type of sheath, the strap to go around the handle could be cut from the same leather as the back, but this would be wasteful and it is more common to have a separate strap (Fig. 11-18C). Leave cutting this to length and fitting the snaps until after assembling the sheath. Then adjustments can be made to get a good fit. How the strap is fitted depends on the back. Some have stitches or one or two rivets holding it on the surface (Fig. 11-18D). It is stronger to take the strap around the back. If the back is not much wider than the knife handle, it can be notched and the strap sewn centrally (Fig. 11-19E). With a wider back it may be better to bring the strap through slots (Fig. 11-18F). Making knife slits for the belt is not enough. There should be pieces cut out. Punch holes for the ends and cut down the sides of the slots (Fig. 11-18G).

Prepare the loop top. Round the edges, stain if desired, and

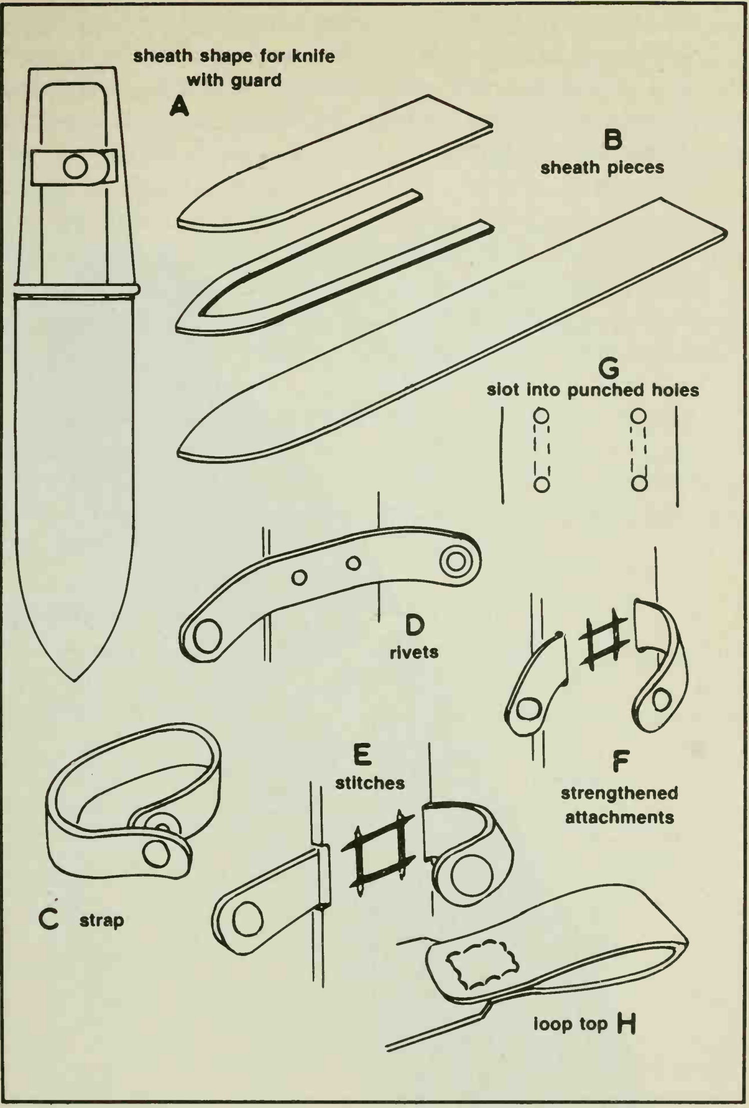


Fig. 11-18. A knife with a full guard has the handle strapped. The top of the sheath forms a belt loop.

glue the loop in place, after softening in water, if necessary. Sew into the back of the blade case, with the stitches sunk in grooves to keep clear of the blade (Fig. 11-18H). Include the handle strap if it is to be contained in the loop, but leave it overlong for adjusting the snap positions to the handle later.

Prepare the filler piece by paring to thickness. If the knife is a type that goes into the sheath one way and has a thick back, make the filler accordingly, with more thickness where the back of the blade comes. Glue, stain, and sew the parts together in the same way as the other sheaths.

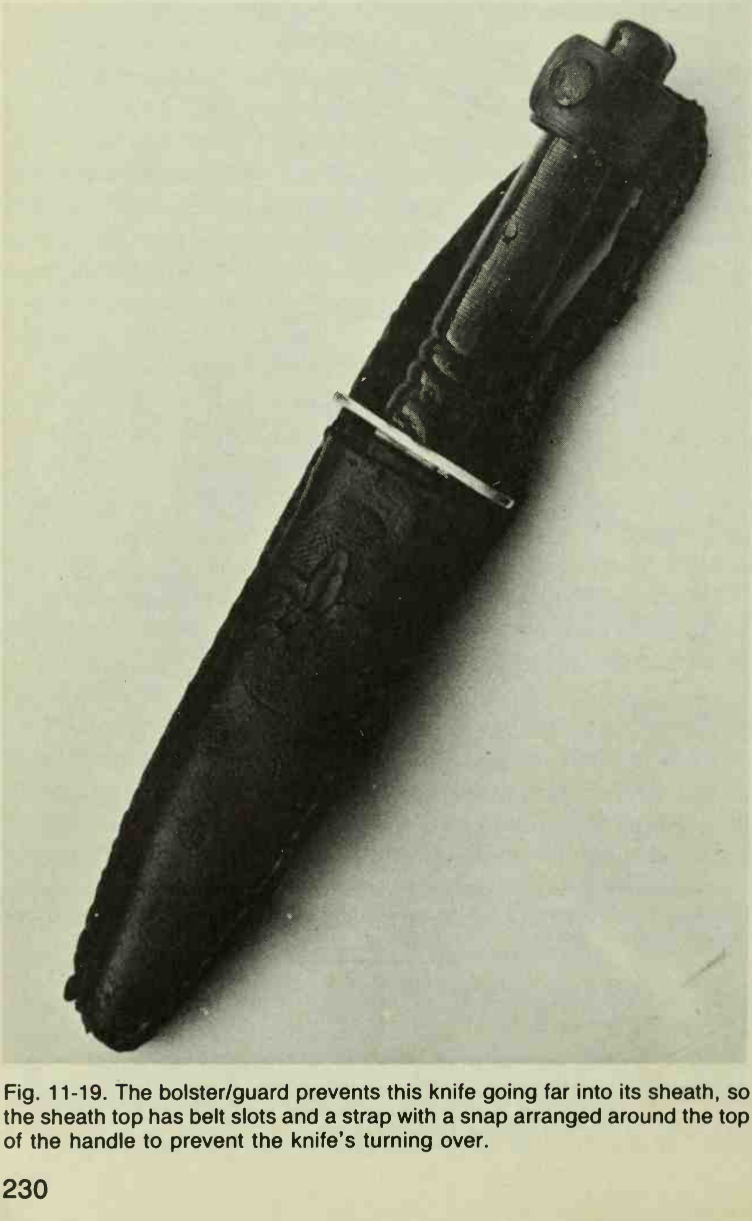


Fig. 11-19. The bolster/guard prevents this knife going far into its sheath, so the sheath top has belt slots and a strap with a snap arranged around the top of the handle to prevent the knife's turning over.

The sheath could be made with a separate belt loop. This cuts leather more economically (Fig. 11-20A). The loop is then a sling for a blade container with a similar back and front. The loop is sewn to the back piece before assembly. A thin piece of leather could be put over the stitching inside to protect it from the blade and this might be glued over the top edge for a neat finish (Fig. 11-20B).

The sheath could be slotted (Fig. 11-20C). The top piece is kept broad. Mark the positions of the slots and punch small holes at their ends. Single knife cuts between the holes should be enough, although wider slots could be cut. The handle strap may be riveted on the front, but if it is to go through, the slots may be notched (Fig. 11-20D).

The strap around the handle need not be a narrow strip, and there is scope for decoration by altering the outline. For a large knife, a broader strap gives better security. This could be made with extending pieces from the back or by sewing on a wide piece and tapering it to the front (Fig. 11-20E).

OTHER SHEATHS

If a belt sheath is needed for a knife with the handle larger than

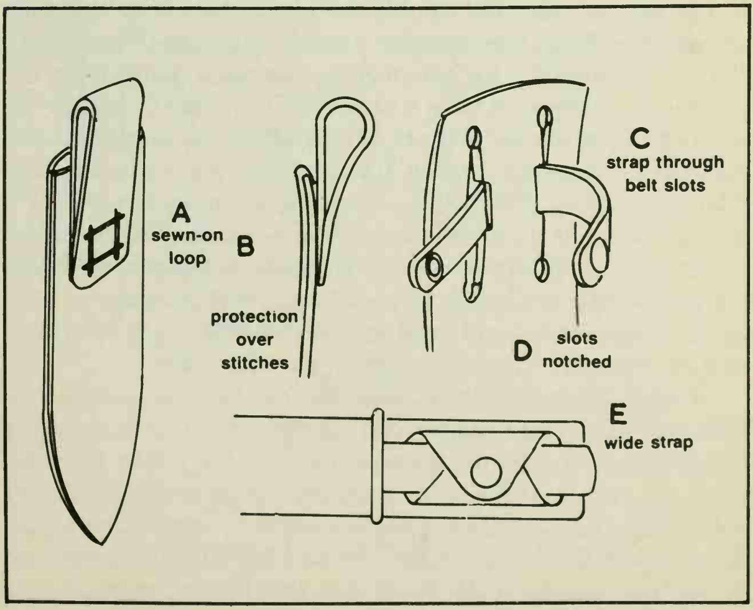


Fig. 11-20. Thin leather may protect stitches through a loop. A strap can be put through a slotted back. A wide strap suits a large knife.

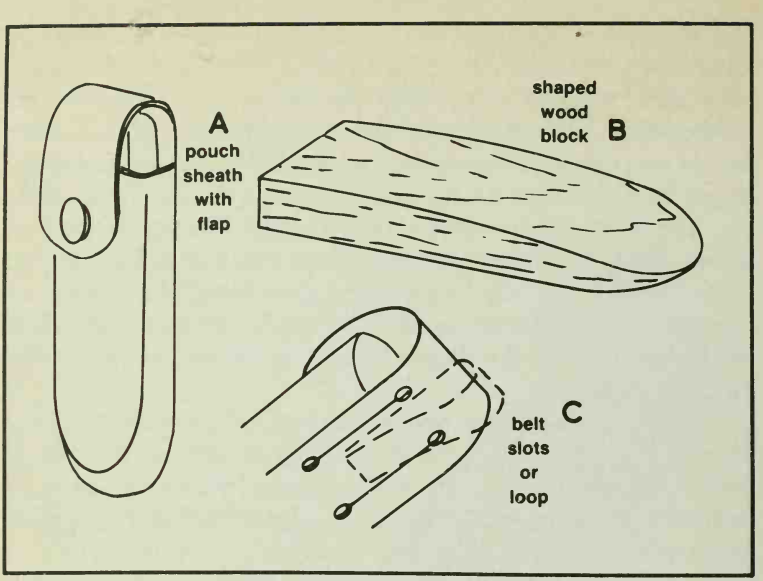


Fig. 11-21. A pouch encloses a short knife. It can be molded over a wood block and may have a strap or slots.

the blade, it may be better to enclose the whole thing. The knife is safe from accidentally coming away, and there is no risk from knocks. The sheath then becomes a pouch with a flap (Fig. 11-21A). For some knives the leather could be one piece folded over, but there will usually have to be a separate front. For the best fit the front should be molded (Fig. 11-22), so the leather needs to be too big at first to allow for shaping. It might be possible to use the knife itself for molding. Protect it by wrapping when the wet leather is pressed over it. If the blade is wider than the handle, leather molded to the actual knife might not allow the blade to be withdrawn past the part fitted to the handle, so it is better to whittle a piece of wood to the shape needed and mold around that (Fig. 11-21B) to keep enough clearance at the entrance to pass the blade.

Dip the front enough to allow the handle to be grasped for removal. The back is made long enough for a flap to come far enough over the front to fasten with a snap. Put a filler piece between the back and front in the usual way. There could be belt slots cut directly in the back, or a belt loop could be sewn on before assembling the front (Fig. 11-21C). Fit the bottom part of the snap to the front and cover the inside with thin leather before sewing around. Locate the other part of the snap and trim the flap to shape after trying the knife in the sheath.

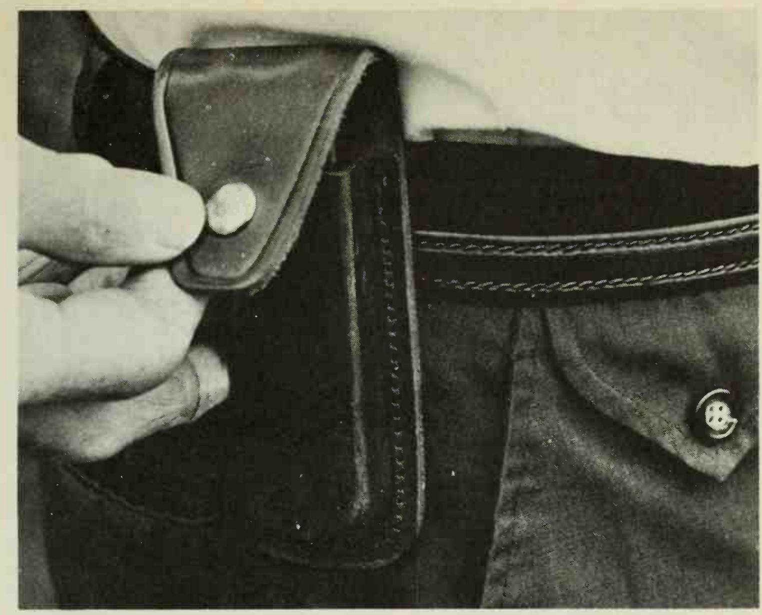


Fig. 11-22. A pouch with a flap and snap fully encloses a knife.

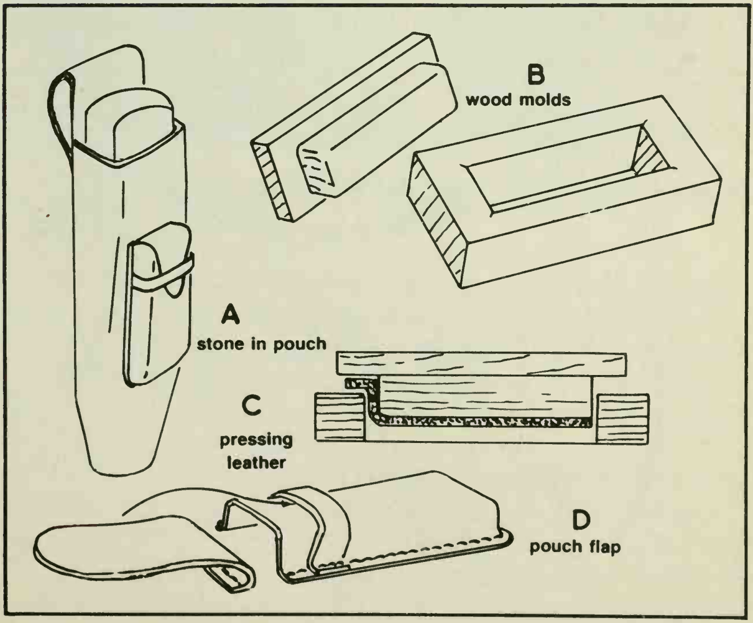


Fig. 11-23. A small sharpening stone can go in a pouch on the front of a knife sheath.

It is useful to carry a small sharpening stone with the knife. Its size will control how it might be carried, but a stone about 3 inches by $\frac{3}{4}$-inch by $\frac{1}{4}$-inch would would go in a pouch on the front of most sheaths (Fig. 11-23A). The leather pouch looks best if it is fairly closely applied by hand. Cut a piece of wood to the shape of the stone and slightly thicker. Attach it to a broader piece. Cut a hole in another piece of wood big enough to pass this and the double thickness of leather, with some space to spare. Round the edges at the entrance (Fig. 11-23B).

Have a piece of leather slightly oversize and soak it long enough in water to make it as limp as possible. Put the leather over the hole, with its face side downward. Locate the other piece of wood over the leather and press it into the slot. Hand pressure will not take it very far. Use a clap or vise to press it farther (Fig. 11-23C). Leave all of this under pressure for the leather to dry. Trim the outline to shape and sew the pouch to the front of the sheath before that is sewn to the back. It may be satisfactory to leave the front pouch open, but it will be better with a flap. There could be a snap, although an alternative for this, or any other, flap sheath is to include a narrow strap in the stitching for the flap to go under (Fig. 11-23D).

If something besides a knife is to be included in a sheath, there

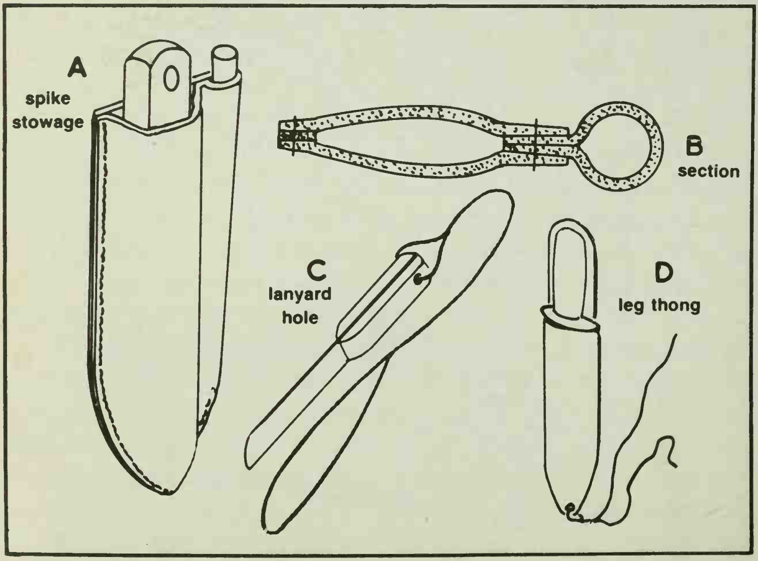


Fig. 11-24. A spike can fit beside a knife. A lanyard protects a knife from dropping, and a thong may hold a sheath to the thigh.

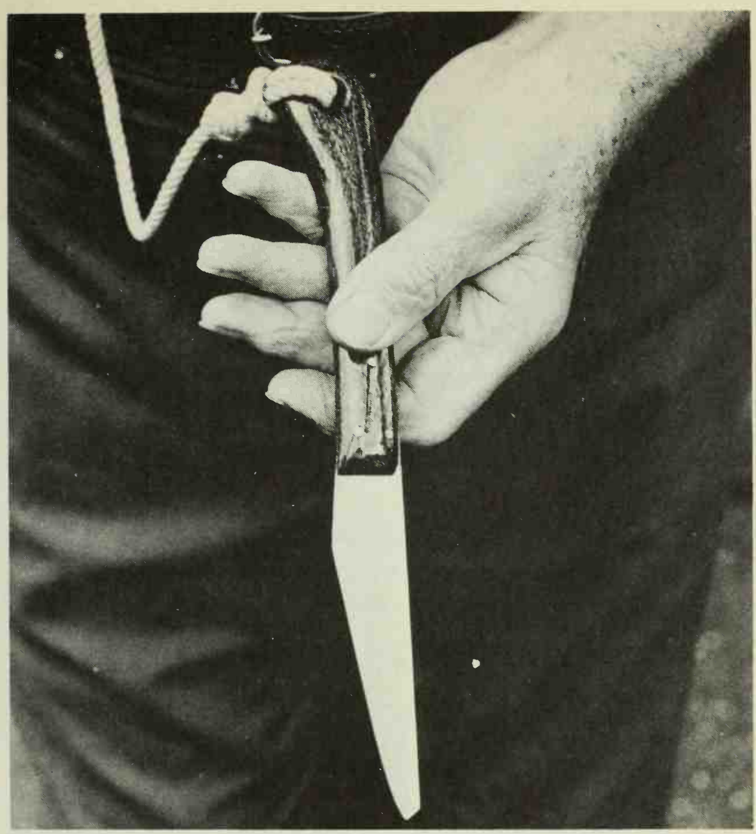


Fig. 11-25. A hole through the end of a handle allows a lanyard to be used when required. This lanyard has a spliced loop put through and doubled back so that it can be removed.

may be wider pieces of leather with a sewn seam between the items, but too wide an assembly becomes clumsy. If one thing is smaller than another, it might be put on the front in a similar way to the sharpening stone. There are sheaths where one knife occupies the main part, and a much smaller knife is carried in another compartment on its front.

For a small item, like a seaman's marline spike, it is possible to include a stowage compactly by folding a piece of leather to go between the back and front of the knife sheath in place of the filler piece at one side (Fig. 11-24A). it can be tapered to suit the spike and be closed with a few stitches at the bottom. If the edges in the seam are thinned slightly, there is little increase in bulk and the assembly remains neat (Fig. 11-24B).

When a knife and other sheathed tools are to be used at a height, as when a seaman is working aloft or a climber is on a cliff face, it is important that precautions are taken against dropping, both because of the nuisance to the user and the danger to anyone below. There should be a hole through the end of the handle for a lanyard (Fig. 11-25). This may be light cord looped around the neck, or it could be a leather thong (Fig. 11-24C). A very long or low-slung sheath may be given a grommet at the bottom and have a thong threaded through it to go around the thigh and hold the sheath close, particularly when getting through undergrowth or in other situations where the sheath might get caught (Fig. 11-24D).

Sheaths for other things can be made by the same methods. A hatchet or small ax is an example. The head has to be enclosed, but the handle can hang uncovered, so a suitable sheath is an enclosed pouch with a hole for the handle (Fig. 11-26A). It can be made from a single piece of leather (Fig. 11-26B). If the hatchet is thin, there can be filers at each side and a little extra width allowed for easy fitting. If the back of the hatchet head is thick, there should be pieces left to overlap where that comes (Fig. 11-26C).

There may be a pair of belt loops on the back (Fig. 11-26D), or it may be sufficient to have widely spaced slots (Fig. 11-26E). The top flap comes over to be fixed with one or two snaps, depending on the size of the sheath. Fix their lower parts before sewing the seams. Have a filler piece next to the edge, and it will help in strengthening the sheath if it curves at the bottom inside (Fig. 11-26F). The hole for the handle should not need strengthening, although a piece of thin leather could be glued to it inside to take the wear if much use is expected. Rivets at the top corners are worthwhile.

The edge of a larger ax can be protected by a leather sheath, although it may be too big to hang on a belt (Fig. 11-26G). The vital part is made from two pieces with a filler around the edges and a reasonably tight fit over the cutting edge. There could be straps to join with a snap over the back of the ax head (Fig. 11-26H). However, some means of adjustment is advisable that so the sheath can be pulled tight. One way of doing this is to extend the side pieces to take two grommets each. Use a thong through them for tightening (Fig. 11-26J).

DECORATION

There is a functional beauty in the fitness for purpose of a

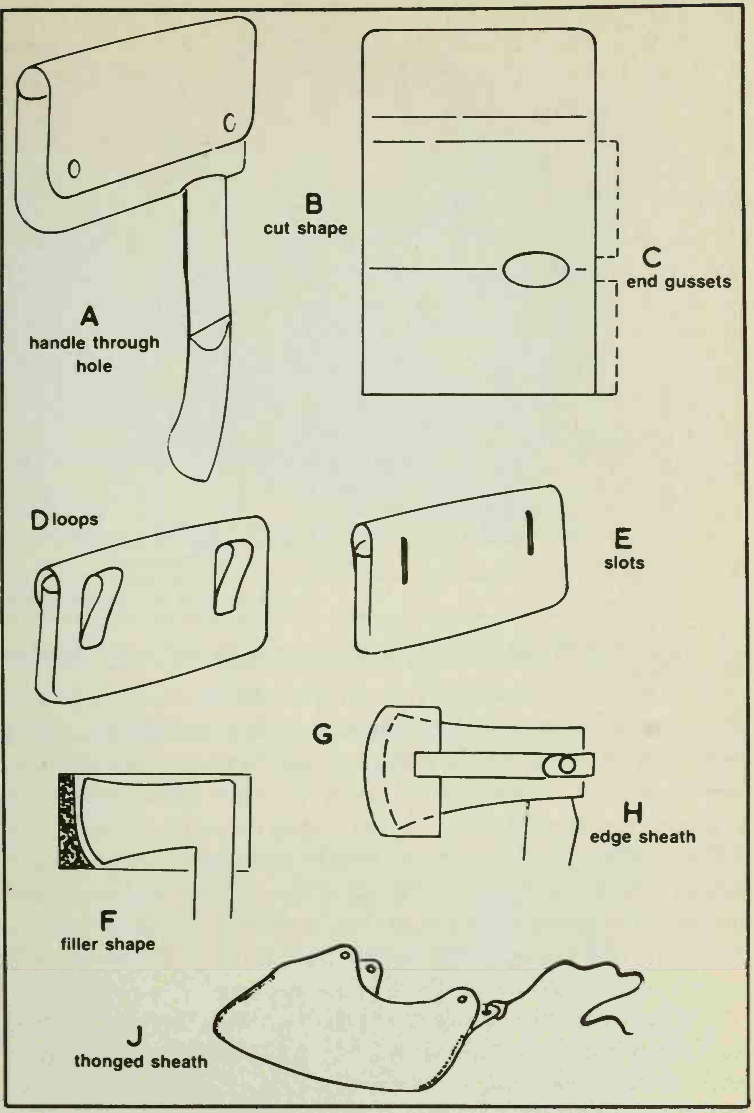


Fig. 11-26. A sheath for a hatchet is a notched wallet. A larger ax has a strap-on sheath.

leather sheath without any applied decoration, but there is scope for tool work on leather.

When some professional leatherwork is examined a dark line is seen parallel with any unsewn edge. Saddlemakers and others

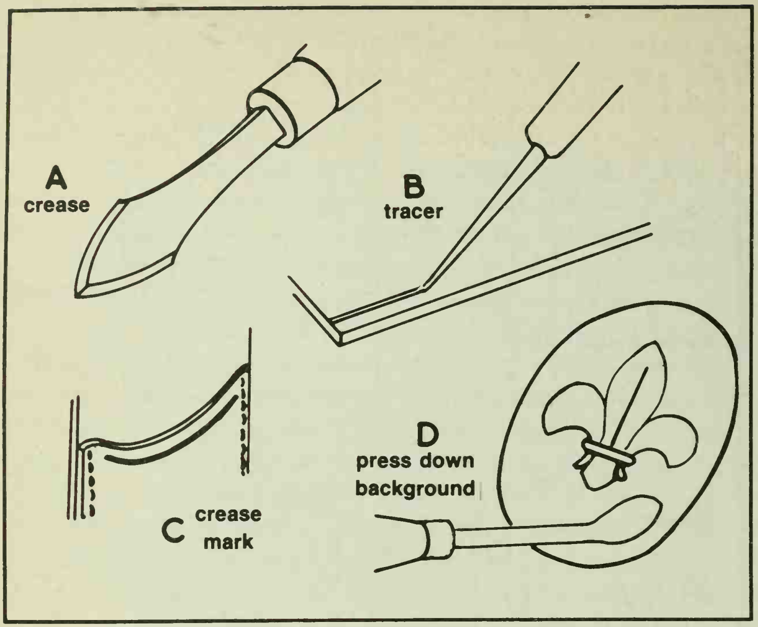


Fig. 11-27. Lines on leather are rubbed with a crease. Backgrounds are lowered by pressing.

would never leave an edge plain, but would mark this line with a tool called a crease. There are many types of creases but the basic one has a heart-shaped end (Fig. 11-27A). In the making of sheaths, the same work could be done with a steel rod with a rounded tip, called a tracer. If drawn across leather with a good pressure, this leaves a dark line (Fig. 11-27B). If either of these tools is heated slightly, the mark is even darker (Fig. 11-28). The place for a crease mark is across the top of the front of a sheath (Fig. 11-27C), as well as any other edge where there is no stitching.

Patterns can be made on the surface of the leather with rubbing and punching tools (Figs. 4-20J, K, L). The effect is similar to shallow surface carving on wood. the design can be drawn on paper, then put over the leather and traced by going over it with a rounded point. The leather should be supported on a firm surface. If it is a completed sheath, a piece of wood may be pushed inside. When the paper has been removed, wet the leather until it becomes soft. Go over the lines again with the tool. Moisture will darken the lines and allow a deeper impression. The design is worked by pressing down the background to leave other parts untouched except for lines on them (Figs. 11-24D and 11-29).

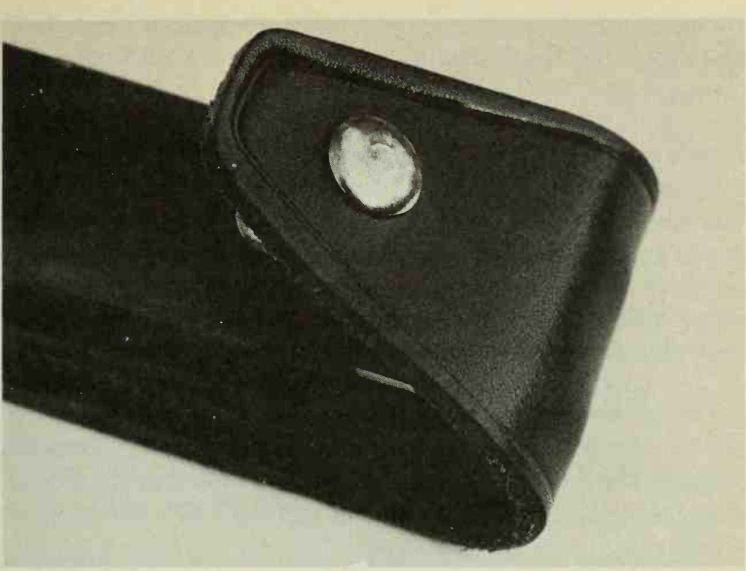


Fig. 11-28. A line pressed with a hot crease tool has been put around the edge of the flap of this snap pouch.

The bent modelling tool with a spooned end (Fig. 4-20K) can be used to rub the background down. The effect of working it many times over the leather is to darken the leather as well as lower it slightly. This may be all that is needed. Heating the tool will make the color darker.

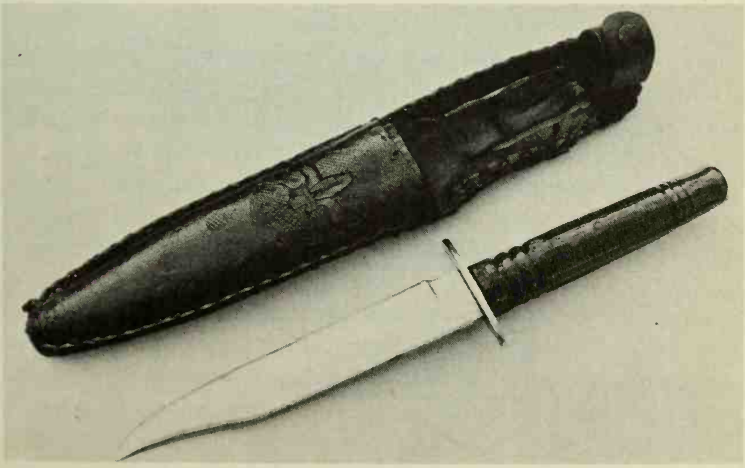


Fig. 11-29. This much-used thonged-edge sheath for a Bowie knife shows its badge displayed by a punched background.

Another method of lowering the background is to punch it. A punch made by filing across the end of a rod (Fig. 4-20L) will make a series of dots. Punches can be bought with many types of patterns. Use a punch all over the background, with marks overlapping and without trying to follow a regular system. It is better for the design to finish with an indiscriminate arrangement of marks. A square punch may be of more use than a round one, as it will go into corners as well as cover the main area. Punching wet leather and/or using the punch hot, will get a darker impression. A design may be tooled before or after staining, as well as on untreated leather. In any case the tooled parts will finish darker.

It is possible to color tooled designs. This can give emphasis to a badge or other pattern. Spirit dyes are used and must be applied carefully because any going where it is not wanted cannot be removed. Use a fine brush and apply quickly and accurately. Drying is almost instantaneous so there is little risk of spreading because of soakage.

Sheaths can be decorated by thonging, as described earlier, instead of sewing with thread. Another method of decoration that carries on the pioneer tradition is to include fringes (Fig. 11-30A). Allow extra length on back and front, then cut into strips about $\frac{1}{8}$-inch wide (Fig. 11-30B). Keep the cuts straight by using a knife along a straightedge. Even if the sheath leather is stiff, working the fringe pieces between the fingers will soften them.

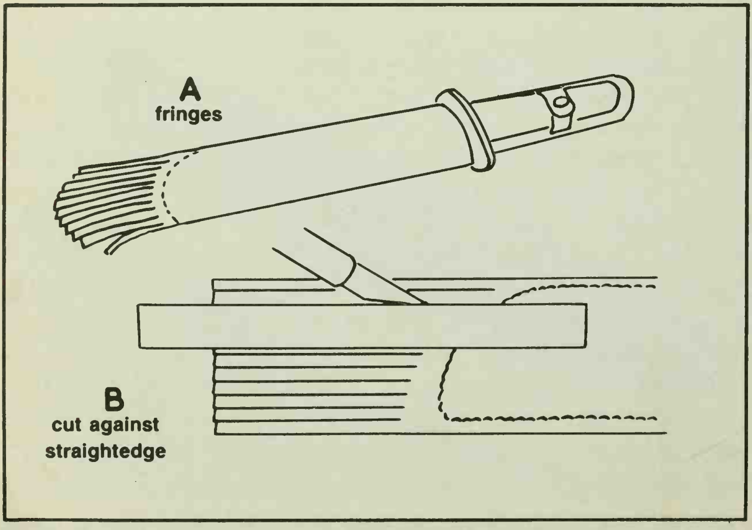


Fig. 11-30. Fringe decoration should be carefully cut.

Glossary

age hardening: Process of becoming harder without special treatment.
alloy: Mixture of two or more metals.
alloy steel: Steel with small quantities of other metals added to impart special qualities.
annealing: Heat-treating steel to soften it as much as possible.
Arkansas: Type of oilstone for sharpening.

back: Side of knife opposite to cutting edge.
blade: All the knife that projects from the handle.
blade, lock: Folding knife with a lever-action locking device.
blade, sheepfoot: Straight-edged blade with round back meeting to a point near a right angle.
blade, walk: Spring end against blade in folding knife.
bolster: Part between handle and blade. See guard.
Bowie knife: Large hunting knife named after James Bowie, an early nineteenth-century pioneer.
brass: Copper and zinc alloy.
brazing: Joining metals with molten brass (spelter).
brine: Salt water mixture used for cooling during heat-treatment.
buffing: Polishing with a cutting compound on a revolving cloth wheel or mop.
bull-nosed: Square-ended tip to blade.
burin: Steel point used for etching.

buff: See wire edge.

butt plate: Pieces fixed on each side of a blade to butt against the handle. May also be the knob at the end of the handle.

carbon: Element added to iron to make steel.

carbon steel: Tool steel made of iron and carbon only.

chisel, thonging: Punch for making thong holes in leather—usually a multiple tool making several holes at a time.

choil: Knick between edge and shoulder.

chopping knife: See cleaver.

clasp knife: Knife with blade that folds into its handle.

cleaver: A knife with a broad blade, also called chopping knife, that is swung like a hatchet.

clip: Beveled hollowed back of a blade taken to a fine point.

convex edge: Edge ground with its bevels having slight outward curves, for strength.

crease: Tool for impressing lines on leather.

dhu, skene: Small sheath knife carried in top of stocking in Scottish Highland dress.

dirk: Dagger or double-edged knife, usually small enough to be easily concealed. Straight or T handle.

double tang: Tang cut away along center, to fit between grips.

draw knife: Cutting tool with handles at ends, intended to be pulled.

dropped edge: Blade with its edge below the level of the handle.

edge: Cutting part of blade.

edge, convex: Edge ground with its bevel having slight outward curves, for strength.

edge, dropped: Blade with its edge below the level of the handle.

edge, wire: The tiny particle of steel clinging to a finely sharpened edge.

exotic steels: Alloy steels.

ferrous: Containing iron.

file side: Opposite side to mark side.

finger grips: Hollows for fingers in edge of handle.

froe: Knife with a lever handle, for splitting wood.

front: Side of knife that includes the cutting edge.

full tang: Tang full-width between slabs or scales.

gimlet knife: Small dirk with T handle.
gimped: Corrugated shapes across back of blade to form grip.
grip: The part of handle shaped to be held firmly.
grip, molded: Handle with finger notches.
grips, finger: Hollows for fingers in edge of handle.
ground, hollow: Cutting edge obtained by grinding each side concave.
ground, wedge: Cutting edge obtained by grinding flat bevels on each side.
guard: Protective piece between handle and blade.

half tang: Full-width tang taken only part way along a handle.
handle, one-piece: Handle with hole for tang.
handle, slab: Made with wood or other slabs or scales on each side of a full-width tang.
hardening: Heat-treating to make the steel as hard as possible.
hard solder: Alternative name for silver solder.
hilt: Handle of sword or dagger.
hollow ground: Cutting edge obtained by grinding each side concave.
honing: Sharpening on an oilstone.

knife, Bowie: Large hunting knife.
knife, chopping: See cleaver.
knife, clasp: Knife with blade which folds into its handle.
knife, draw: Cutting tool with handles at ends, intended to be pulled.
knob: End of handle away from blade, shaped to prevent hand slipping.

lock blade: Folding knife with a lever-action locking device.

machete: Large slashing knife.
mark, nail: Nick in back of blade of folding pocket knife for opening.
mark, side: The side of the blade with the maker's name.
Micarta: Trade name of plastic suitable for handles.
modeller: Tool with flattened end for decorating leather.
molded grip: Handle with finger notches.
mop: A buffing wheel.

nail mark: Nick in back of blade of folding pocket knife for opening.
nonferrous: Alloy without iron.
normalizing: Reducing internal stresses by same heat-treatment as annealing.

one-piece handle: Handle with hole for tang.

pins: Handle fixing like rivets without the ends spread.
plate, butt: Pieces fixed on each side of a blade to butt against the handle.
point: Tip of blade, even if rounded. Also tip.
polishing: Final finishing process. Also buffing.
pouch sheath: Leather sheath that encloses most of the handle as well as the knife blade.

refining: Alternative name for hardening.
rest, thumb: Hollow in back of blade above bolster or guard.

scale: Divider in a pocket knife. Sometimes the pieces on each side of a handle forming the grip.
scorp: Curved draw knife.
seasoning: Removing excess moisture from wood.
sheath, pouch: Leather sheath that encloses most of the handle as well as the knife blade.
sheath, snap: Leather sheath that encloses the blade and the handle is held by a strap with a press stud (snap).
sheepfoot blade: Straight-edged blade with round back meeting to a point near a right angle.
shoulder: Thick part of blade between edge and guard or handle.
side, file: Opposite side to mark side.
side, mark: The side of the blade with the maker's name.
silver solder: Spelter with its melting temperature lowered by the addition of silver.
silver steel: Good quality precision-ground tool steel.
skene dhu: Small sheath knife carried in top of stocking in Scottish Highland dress.
slab handle: Made with wood or other slabs or scales on each side of a full-width tang.
slabs: Pieces of wood or other material used on each side of a full tang to make a handle. Also scales.
snap: Press stud used on a sheath.

snap sheath: Leather sheath that encloses the blade and the handle is held by a strap with a press stud (snap).
solder, silver: Spelter with its melting temperature lowered by the addition of silver. Also hard solder.
spelter: Brass used for brazing.
spey blade: A thick-pointed blade end.
stainless steel: Alloy steel with corrosion-resisting qualities.
steel, alloy: Steel with small quantities of other metals added to impart special qualities.
steel, carbon: Tool steel made of iron and carbon only.
steel, stainless: Alloy steel with corrosion-resisting qualities.
steels, exotic: Alloy steels.
strop: Leather strip used for final sharpening. The action of using it.
swedge: The part of the bevel of a blade away from the edge.
swell: Thickening at end of handle.

tang: Projection from blade into handle.
tang, double: Tang cut away along center, to fit between grips.
tang, full: Tang full-width between slabs or scales.
tang, half: Full-width tang taken only part way along a handle.
tempering: Reducing hardness and brittleness of hardened steel.
thonging: Leather strip used in making a sheath.
thonging chisel: Punch for making thong holes in leather—usually a multiple tool making several holes at a time.
thumb rest: Hollow in back of blade above bolster or guard.
tines: Prongs of a fork.
tip: See point.
tracer: Tool with rounded point for making leather.

ulu: Side cutting Eskimo knife.

walk, blade: Spring end against blade in folding knife.
Washita: Type of oilstone for sharpening.
wedge ground: Cutting edge obtained by grinding flat bevels on each side.
whet: Sharpen on oilstone, but could be on stone lubricated with water.
wire edge: The tiny particle of steel clinging to a finely sharpened edge.

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